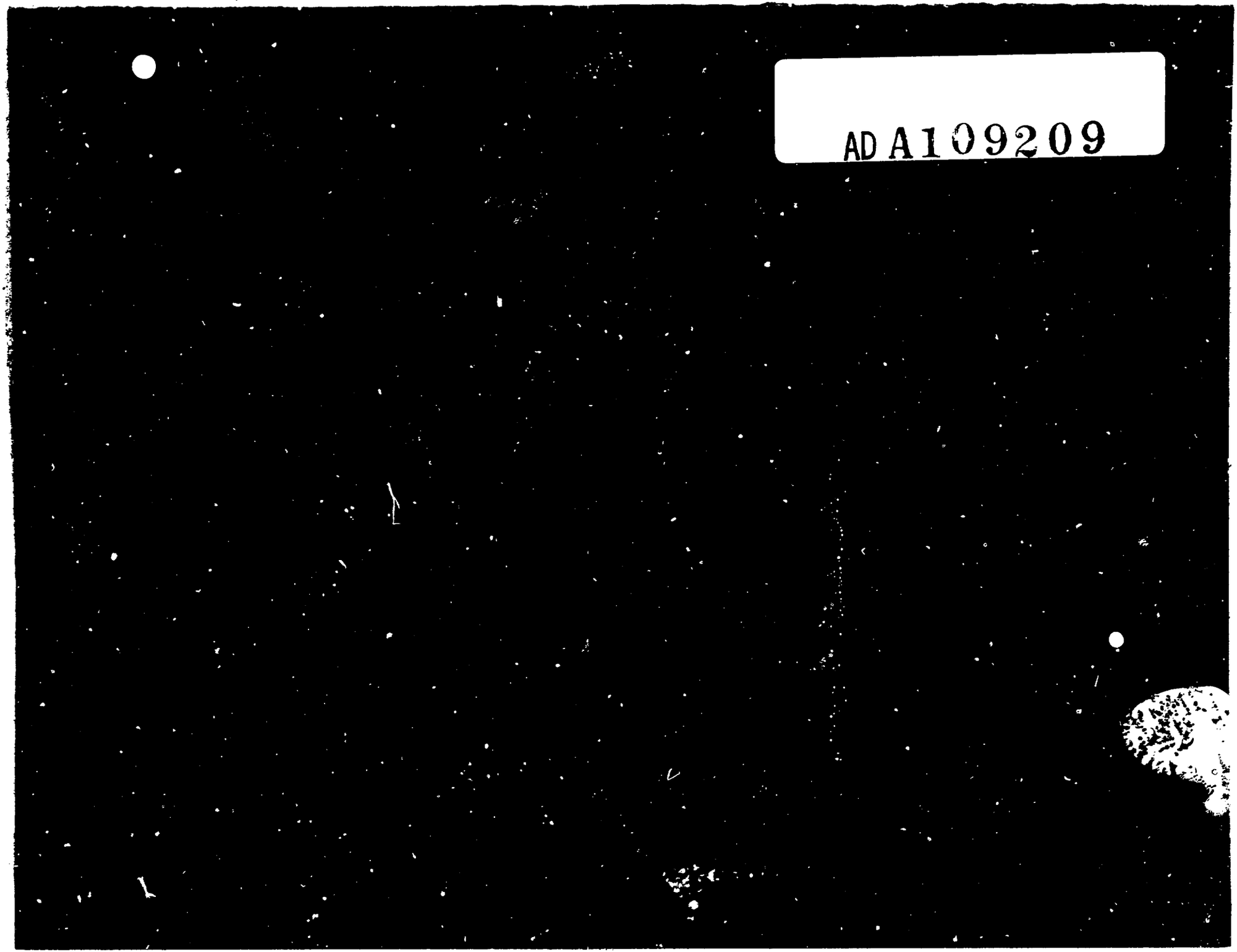

DELAWARE RIVER BASIN

ELK LAKE RUN, WAYNE COUNTY

PENNSYLVANIA

ELK LAKE DAM

NDI ID No. PA-01102
DER ID No. 64-4

ELK LAKE DEVELOPMENT ASSOCIATION, INC.

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

DACW31-81-C-0018

Prepared by

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
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P.O. Box 1963
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For

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

JULY 1981

PREFACE

This report is prepared under guidance contained in Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

ELK LAKE DAM

NDI ID No. PA-01102; DER ID No. 64-4

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

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PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITION

AND

RECOMMENDED ACTION

Name of Dam:	Elk Lake Dam NDI ID No. PA-01102 DER ID No. 64-4
Size:	Intermediate (10.8 feet high; 3,220 acre-feet)
Hazard Classification:	High
Owner:	Elk Lake Development Association, Inc. Robert Howell, President 1504 East Street Honesdale, PA 18431
State Located:	Pennsylvania
County Located:	Wayne
Stream:	Elk Lake Run
Date of Inspection:	4 June 1981

Based on the criteria established for these studies, Elk Lake Dam is judged to be in fair condition. The recommended Spillway Design Flood (SDF) for the size and hazard classification of the dam is the Probable Maximum Flood (PMF). The existing spillway will pass about 84 percent of the PMF before overtopping of the dam occurs. The spillway capacity is rated as inadequate.

Several deficiencies were observed at the dam. The most serious is the probable lack of an adequate impervious barrier through the dam. Although some maintenance has been performed, the existing maintenance program could be upgraded.

The following remedial measures, listed in approximate order of priority, are recommended to be undertaken by the Owner without delay:

(1) Clear brush and debris on and adjacent to the dam.

(2) Engage the services of a professional engineer experienced in the design and construction of dams. Utilize his advice in removing the trees on and near the embankment. If any seepage becomes evident after the brush, trees, and debris are removed, the condition should be assessed by the engineer.

(3) Fill the slots by the spillway bridge with concrete or other suitable impervious material.

(4) Fill the burrowing animal hole adjacent to the spillway with suitable impervious material.

In addition, the Owner should institute the following operational and maintenance procedures:

(1) Develop a detailed emergency operation and warning system for Elk Lake Dam. The dwellings around the Lake should be included in the warning system. When warnings of a major storm are given by the National Weather Service, the Owner should activate the emergency operation and warning system.

(2) During periods of unusually heavy rains, provide round-the-clock surveillance of the dam, including continuous surveillance of the downstream slope for evidence of seepage. In addition, have sufficient personnel available to clear any debris that may collect at the spillway.

(3) As presently required by the Commonwealth, expand the inspection program to include a formal annual inspection by a professional engineer experienced in the design and construction of dams. Utilize the inspection results to determine if remedial measures are necessary.

(4) Expand the existing maintenance program and develop a formal maintenance manual so that all features of the dam are properly maintained.

ELK LAKE DAM

Submitted by:

GANNETT FLEMING CORDDRY
AND CARPENTER, INC.

Frederick Futchko

FREDERICK FUTCHKO
Project Manager, Dam Section

Date: 7 August 1981

Approved by:

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF
ENGINEERS

James W. Peck

JAMES W. PECK
Colonel, Corps of Engineers
Commander and District Engineer

Date: 18 Aug 81

ELK LAKE DAM

Overview

ELK LAKE DAM

NDI ID No. PA-01102; DER ID No. 64-4

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

SECTION 1

PROJECT INFORMATION

1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of project.

a. Dam and Appurtenances. Elk Lake Dam is partly a dry stone masonry dam, partly an earthfill embankment dam, and partly a composite dry stone masonry and earthfill dam. The extent of the dry stone masonry, much of which is covered with earthfill, is uncertain. The dam is 10.8 feet high and its length, including the spillway, is 175 feet.

The spillway is located about 40 feet to the left of the right abutment. In plan, the weir is a series of chords along an arc. The weir is constructed of concrete and is 1.5 feet high and 22.3 feet long. There is a concrete apron immediately downstream of the weir that converges rapidly to a 4.5-foot wide U-shaped concrete chute that extends through the dry masonry section of the dam. A concrete foot bridge crosses the chute. The outlet works is a 1.2-foot deep by 2.0-foot wide stoplog slot in the spillway weir.

The various features of the dam are shown on the photographs in Appendix C and on the plates in Appendix E. A description of the geology is included in Appendix F.

b. Location. Elk Lake Dam is located on an unnamed stream, termed Elk Lake Run for the purposes of this Report, in Clinton Township, Wayne County, Pennsylvania. The dam is shown on USGS Quadrangle, Forest City, Pennsylvania, at latitude N 41° 37.7' and longitude W 75° 23.4'. The upstream end of the reservoir is shown on USGS Quadrangle, Waymart, Pennsylvania. The dam is about 3.4 miles north of Waymart, Pennsylvania. A location map is shown on Plate E-1 in Appendix E.

c. Size Classification. Intermediate (10.8 feet high; 3,220 acre-feet).

d. Hazard Classification. Downstream conditions indicate that a high hazard classification is warranted for Elk Lake Dam (Paragraphs 3.1e and 5.1c(5)).

e. Ownership. Elk Lake Development Association, Inc.; Robert Howell, President, 1504 East Street, Honesdale PA 18431.

f. Purpose of Dam. Recreation.

g. Design and Construction History. The Pennsylvania Water Supply Commission (PWSC) prepared a report on the dam in 1914. The following is quoted from that report.

> "This dam, an earthen embankment, semi-circular in plan, and approximately 200 feet long on the center line, at the outlet of a natural pond, was built sometime between 1860-65, by the Delaware & Hudson Company. It is about 11 feet in maximum height, and 16 feet wide on top, with both the upstream and downstream sides protected and retained by dry stone walls, having an outside batter of from 3 to 6 inches per foot.
>
> Through the middle of the dam is a masonry outlet structure, consisting of two parallel walls, 7 feet apart, 20 feet long and about 2-1/2 feet thick on top, which were probably built up with mortar, although no signs of any remains. The original means of control was by flashboards, or timber gates, supported by timbers, notched and braced into the masonry walls, and the maximum high water level maintained by the Delaware & Hudson Company was about 1 foot below the crest of the dam. A farmer living near the dam says there is a 'sheet wall', with double planking on its upstream side, extending through and under the dam to hardpan. At the time of the examination it was found that the space between the side walls of the outlet structure had been filled with a dry wall of small stones, to a height of about 4-1/2 to 5 feet, on top of which was a slab

of concrete, about 3-1/2 feet thick and 6 feet long, with its top 3 feet below the top of the dam. Through this concrete was a notch, 3 feet wide, and 21 inches deep, at the upstream end of which were recesses for flash or weir boards, to control the water level of the lake. It seemed probable, and the farmer said that the concrete extended to the old 'sheet wall' on the upstream side of the dry wall, mentioned above. A coffer dam was built 30 feet upstream from the outlet works, and the intervening space was filled with earth and stone, 'a load of dirt and a load of stone', the writer was informed to within about 3 feet of the surface of the water."

According to the PWSC, the lake was acquired circa 1898 by the Lake Lodore Improvement Company, along with two other lakes in the vicinity. Since they had no use for Elk Lake, in 1904 they breached the dam and dug a channel to the natural lake, which drained the lake to its natural level. Farmers living around the lake objected to the lowered water level and "...from time to time, replaced the timbers and flashboards, and sometime during the years 1912 and 1913, filled in the channel above mentioned, and placed concrete and flashboards in the outlet, so that at the time of the examination the water was about 3 feet below the crest of the dam."

Between 1914 and 1962, the ownership of the dam and lake was in dispute. The dispute was apparently settled by jury trial in 1962. As described by the present Owner, the Lake Lodore Improvement Company owns the lake and the Elk Lake Development Company owns the dam.

The Commonwealth has inspected the dam at various times between 1924 and 1965. The dam had deteriorated to such an extent by 1948 that repairs were ordered. As nothing was done, repairs were ordered again in 1952 and 1962. By 1963, some repairs had been made. By 1965, concrete liner walls had been constructed along the spillway chute. These walls had stoplog slots and further arguments ensued concerning the level of the lake.

The Owner stated that the last improvements made to the dam were accomplished about 1965. However, comparing a photograph taken in 1968 with existing conditions reveals that the existing spillway chute walls and the existing weir were constructed after 1968.

h. Normal Operational Procedure. The reservoir is maintained at the spillway crest. The Owner reports that the stoplog is usually removed during the winter months.

1.3 Pertinent Data.

a.	Drainage Area. (square miles)	0.9
b.	Discharge at Damsite. (cfs)	
	Maximum known flood	Unknown
	Outlet works at normal pool elevation	8
	Spillway capacity at maximum pool	211
c.	Elevation. (feet above msl.)	
	Top of dam	1423.1
	Maximum pool	1423.1
	Normal pool (spillway crest)	1419.0
	Invert of stoplog slot	1417.8
	Streambed at toe of dam (natural lake level)	1412.3
d.	Reservoir Length. (miles)	
	Natural lake	Unknown
	Normal pool	0.83
	Maximum pool	0.86
e.	Storage. (acre-feet)	
	Natural lake	1,559
	Normal pool	2,448
	Maximum pool	3,220
f.	Reservoir Surface. (acres)	
	Natural lake	113
	Normal pool	153
	Maximum pool	200
g.	Dam.	
	Type	Dry stone masonry and earthfill.
	Length (feet)	175, including spillway.
	Height (feet)	10.8
	Top Width (feet)	Varies; 12 to 15.
	Side Slopes	
	Upstream	Varies; 1V on 1.7H to 1V on 5.9H.

g.	Dam. (cont'd.)	
	Downstream	Varies; Dry stone masonry is near-vertical; Earthfill varies 1V on 2.4H to 1V on 5.5H.
	Zoning	Earthfill and dry stone masonry.
	Cutoff	Unknown
	Grout Curtain	None
h.	Diversion and Regulating Tunnel.	None
i.	Spillway.	
	Type	Concrete weir with inclined crest.
	Length of Weir (feet)	22.3
	Crest Elevation (feet above msl.)	1419.0
	Upstream Channel	Reservoir; Lake bottom has 1V on 20H adverse slope.
	Downstream Channel	4.5-foot wide concrete chute through dam to natural stream. Chute becomes control for all except low flows.
j.	Regulating Outlets.	One 1.2-foot deep by 2-foot wide stoplog slot in spillway weir.

SECTION 2

ENGINEERING DATA

2.1 Design.

a. Data Available. There is no design information for Elk Lake Dam.

b. Design Features. The project is described in Paragraph 1.2a. The various features of the dam are shown on the photographs in Appendix C and on Plates E-2 and E-3 in Appendix E.

c. Design Considerations. There is insufficient information to assess the design of the dam.

2.2 Construction.

a. Data Available. There is very little information concerning the original construction of the dam and subsequent modifications to it.

b. Construction Considerations. There are insufficient data to assess the construction of the dam.

2.3 Operation. There are no formal records of operation. Records of inspections performed by the Commonwealth are available for the period from 1924 to 1965. A summary of the inspection reports is included in Appendix A.

2.4 Evaluation.

a. Availability. Some data were provided by the Bureau of Dams and Waterway Management, Department of Environmental Resources, Commonwealth of Pennsylvania (PennDER). The Owner was available for information during the visual inspection.

b. Adequacy. The type and amount of available design and other engineering data are very limited. The assessment of the dam is based on the combination of available data, visual inspection, performance history, hydrologic and hydraulic assumptions, and calculations developed for this report.

c. Validity. There is no reason to question the validity of the available data.

SECTION 3

VISUAL INSPECTION

3.1 Findings.

a. General. The overall appearance of the dam and appurtenant structures is fair. Deficiencies are described in the following paragraphs. Survey data acquired for the inspection are shown on Plates E-2 and E-3 in Appendix E. The visual inspection checklist and sketch of the dam indicating deficiencies are presented in Appendix B. A profile of the top of the dam is included in Appendix D. Datum for the survey was assumed at the spillway crest, Elevation 1419.0, as determined from USGS mapping. On the day of the inspection, the Lake was at the spillway crest level.

b. Embankment. The embankment is in fair condition. The leftmost 70 feet of the embankment appears to be entirely earthfill. The grass cover is well maintained (Photograph G). To the right of this section, the embankment appears to be a composite earthfill and dry stone masonry section, except at the spillway, where the embankment is entirely dry stone masonry. Except immediately adjacent to the spillway, the dry stone masonry at the downstream toe is displaced and bulged (Photographs A and B). Brush covers most of the dry stone masonry. At the toe of the dry stone masonry, directly beneath the spillway chute, debris is piled from streambed to the invert of the chute (Photograph A). This debris totally obscures the toe of the dam at streambed. Mature trees are growing on the embankment just to the left and right of the spillway chute and adjacent to the embankment at the right abutment (Photograph D).

There is a relatively large burrowing animal hole in the embankment, near the upstream toe, at the left end of the spillway weir. Just downstream from the spillway bridge, there is a slot in the embankment on each side, as shown on Exhibit B-1. The left slot was probed to a depth of 3 feet. The interior of the right slot is visible (Photograph F). It is 6 feet deep and contains the remains of timber planking. The Owner did not know the reason for the existence of the slots.

c. Appurtenant Structures. The spillway weir and concrete chute are in good condition (Photographs C and E). Only minor shrinkage cracking of the concrete is evident. The stoplog in the small stoplog slot is in good condition (Photograph C).

d. Reservoir Area. The watershed is mostly forest or meadowland. The only significant development is around the lake itself. Some of the dwellings around the lake are below top of dam elevation. The lake itself comprises a significant part of the watershed.

e. Downstream Conditions. There are two mobile homes located immediately downstream of the embankment to the left of the spillway. From the dam, the stream extends along a narrow valley for about 500 feet, where it passes under Elk Lake Road. Along this reach are 2 or 3 dwellings that would receive property damage as a result of a dam failure. The stream then extends for 3.7 miles along an uninhabited valley until it flows into Little Keen Pond, which is impounded by Little Keen Pond Dam. Keen Lake Dam is 0.3 mile downstream of Little Keen Pond Dam. The estimated effects of a dam failure are described in Section 5. It is possible that three or more lives would be lost in the event of a dam failure. Accordingly, a high hazard classification is warranted for Elk Lake Dam.

SECTION 4

OPERATIONAL PROCEDURES

4.1 Procedure. The reservoir is normally maintained at the spillway crest with excess inflows discharging over the spillway and into the downstream channel. The stoplog is reportedly removed during the winter months. The dam is checked daily by the Owner's security patrol.

4.2 Maintenance of Dam. There are no established procedures for maintenance of the dam. Maintenance work has generally been performed on an unscheduled basis. Maintenance of the embankment is generally good in some areas but, as noted in Section 3, there are maintenance deficiencies on the embankment near the spillway. Although the dam is checked daily by the Owner, no formal reports are maintained.

4.3 Maintenance of Operating Facilities. The only operating facility is the stoplog, which is well maintained.

4.4 Warning Systems in Effect. There is no emergency operation and warning system for the dam.

4.5 Evaluation of Operational Adequacy. Although some maintenance is performed, the current program could be improved. Annual inspections by a professional engineer are necessary to detect hazardous conditions at the dam. An emergency operation and warning system is necessary to reduce the risk of dam failure should adverse conditions develop and to prevent loss of life should the dam fail.

SECTION 5

HYDROLOGY AND HYDRAULICS

5.1 Evaluation of Features.

a. Design Data. There are no hydrologic or hydraulic design calculations available for Elk Lake Dam.

b. Experience Data. The Owner believes the flood of record occurred during the flood of May 1942, when the lake was reportedly 8-inches above normal level. There are no data to estimate the flow at the dam during this storm because the dimensions of the then existing spillway are uncertain.

c. Visual Observations.

(1) General. The visual inspection of Elk Lake Dam, which is described in Section 3, resulted in a number of observations relevant to hydrology and hydraulics.

(2) Embankment. There are no deficiencies pertinent to hydrology and hydraulics at the embankment.

(3) Appurtenant Structures. There is a potential for collection of debris in the spillway chute, because it narrows rapidly. The pile of debris at the toe of the chute accentuates this potential. Since the underside of the bridge over the spillway chute is at top of dam elevation, the bridge would increase the potential for collection of debris.

In the analysis described in Appendix D, the debris collection potential has been ignored. The analysis in Appendix D also indicates that the spillway chute would be the control for all flows except low flows. This shift in control has been included in determining the spillway capacity.

The only outlet works facility at the dam is the stoplog in the spillway weir. It is capable of drawing down the pool by 1.2 feet. As described in Paragraph 5.1c(5), the dam is only considered to be of significant hazard with the lake at normal pool elevation. Because of this lessened hazard at normal pool and because of the very flat lake bottom slope upstream of the dam, constructing an outlet works facility capable of drawing the pool down further is not considered practical or necessary, and the present facility is considered adequate.

(4) Reservoir Area. No conditions were observed in the watershed or reservoir area that might present a hazard to the dam. Since some of the dwellings along the lake shore are below top of dam elevation, warning residents around the lake is warranted as part of the emergency warning system. Because of the significant surcharge storage provided by the large lake area, the dam provides significant flood control for the area immediately downstream.

(5) Downstream Conditions. The debris at the toe of the spillway chute is not sufficiently high at present to reduce the spillway capacity. If the dam were to fail with the lake at normal pool elevation, damage would be limited to long-term flooding of some roads in the area. For this condition, it is judged that the peak outflow could be safely passed by Little Keen Pond Dam and by Keen Lake Dam. A Phase I National Dam Inspection Program has previously been prepared for Keen Lake Dam, which is an intermediate size, high hazard dam with a seriously inadequate spillway. A high hazard classification is warranted for Elk Lake Dam because, when the lake is near the top of the dam, a failure could result in the flooding of two mobile homes and possibly contribute to the overtopping of Little Keen Pond and Keen Lake Dams.

d. Overtopping Potential.

(1) Spillway Design Flood. According to the criteria established by the Office of the Chief of Engineers (OCE), the Spillway Design Flood (SDF) for the size (intermediate) and hazard potential (high) of Elk Lake Dam is the Probable Maximum Flood (PMF). The watershed and reservoir were modeled with the U.S. Army Corps of Engineers HEC-1DB computer program. A description of the model is included in Appendix D. The assessment of hydrology and hydraulics is based on existing conditions, and the effects of future development are not considered.

(2) Summary of Results. Pertinent results are tabulated at the end of Appendix D. The analysis reveals that the existing Elk Lake Dam can pass about 84 percent of the PMF before overtopping of the dam occurs.

(3) Spillway Adequacy. The criteria used to rate the spillway adequacy of a dam are described in Appendix D. Because Elk Dam can pass the 1/2 PMF but not the PMF, which is the SDF, the spillway capacity is rated as inadequate.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations.

(1) General. The visual inspection of Elk Lake Dam, which is described in Section 3, resulted in a number of observations relevant to structural stability. These observations are evaluated herein for the various features.

(2) Embankment. Brush and debris are objectionable because they obscure the embankment and might hide evidence of problems. Trees are objectionable because the root systems create seepage paths through the embankment. The displaced and bulged dry stone masonry could be an indication of movement within the embankment. However, a photograph dated 1938 shows almost identical displacement. Some other photographs, believed to date from 1914, show a similar condition. Therefore, the bulging and displacement are not recent and warrant no more than visual monitoring. Burrowing animal holes in the embankment are objectionable because they provide seepage paths.

The slots immediately downstream from the spillway bridge served an unknown purpose. During major floods, water could overtop the concrete chute walls and flow through the slots into the embankment area. This would raise the phreatic surface (saturation line) in the embankment, which could have an adverse effect on the structural integrity of the dam.

(3) Appurtenant Structures. There are no structural deficiences at the spillway or outlet works.

b. Design and Construction Data. From the descriptions given in Paragraph 1.1g, it is evident that there is no section that could be considered typical for the dam. There is scant evidence of an impervious barrier through the dam. The remains of the impervious barrier could have been the material observed in the slot to the right of the spillway chute. Areas adjacent to the spillway appeared to be soil placed directly on dry masonry.

c. Operating Records. There are no formal records of operation. The periodic inspections by the Commonwealth reveal that the dam leaked severely during some of these inspections. This reinforces the conclusion that there is an inadequate impervious barrier within the embankment.

However, it is noted that during the 1/2 PMF, the pool would only rise to elevation 1421.5, or 2.5 feet above the spillway crest. This is not considered a large increase in head over existing conditions. It is also noted that the dam has existed for 120 years without any major problems.

d. Post-Construction Changes. The many post-construction changes, most of which are undocumented, have been described in Paragraph 1.1g and are assessed with the dam.

e. Seismic Stability. Elk Lake Dam is located in Seismic Zone 1 where earthquake loadings are not considered to be significant for low dams with no readily apparent stability problems. Since no readily apparent stability problems were observed, the seismic stability of the dam is considered to be adequate.

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND PROPOSED REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety.

(1) Based on criteria established for these studies, Elk Lake Dam is judged to be in fair condition. The recommended Spillway Design Flood (SDF) for the size and hazard classification of the dam is the PMF. The existing spillway will pass about 84 percent of the PMF before overtopping of the dam occurs. The spillway capacity is rated as inadequate.

(2) Several deficiencies were observed at the dam. The most serious is the probable lack of an adequate impervious barrier through the dam.

(3) Although some maintenance has been performed, the existing maintenance program could be upgraded.

(4) A summary of the features and observed deficiencies is as follows:

Feature	Observed Deficiency
Embankment	Trees growing on and near embankment; burrowing animal hole; debris at toe of embankment.
Spillway	Potential for collection of debris.

b. Adequacy of Information. The information available is such that an assessment of the condition of the dam can be inferred from the combination of available data, visual inspection, past performance, and computations performed as part of this study.

c. Urgency. The recommendations in Paragraph 7.2 should be implemented without delay.

d. Necessity for Further Investigations. Further investigations by the Owner will not be required to accomplish the remedial measures.

7.2 Recommendations and Remedial Measures.

a. The following remedial measures, listed in approximate order of priority, are recommended to be undertaken by the Owner without delay:

(1) Clear brush and debris on and adjacent to the dam.

(2) Engage the services of a professional engineer experienced in the design and construction of dams. Utilize his advice in removing the trees on and near the embankment. If any seepage becomes evident after the brush, trees, and debris are removed, the condition should be assessed by the engineer.

(3) Fill the slots by the spillway bridge with concrete or other suitable impervious material.

(4) Fill the burrowing animal hole adjacent to the spillway with suitable impervious material.

b. In addition, the Owner should institute the following operational and maintenance procedures:

(1) Develop a detailed emergency operation and warning system for Elk Lake Dam. The dwellings around the lake should be included in the warning system. When warnings of a major storm are given by the National Weather Service, the Owner should activate the emergency operation and warning system.

(2) During periods of unusually heavy rains, provide round-the-clock surveillance of the dam, including continuous surveillance of the downstream slope for evidence of seepage. In addition, have sufficient personnel available to clear any debris that may collect at the spillway.

(3) As presently required by the Commonwealth, expand the inspection program to include a formal annual inspection by a professional engineer experienced in the design and construction of dams. Utilize the inspection results to determine if remedial measures are necessary.

(4) Expand the existing maintenance program and develop a formal maintenance manual so that all features of the dam are properly maintained.

APPENDIX A

CHECKLIST - ENGINEERING DATA

CHECKLIST

ENGINEERING DATA

DESIGN, CONSTRUCTION, AND OPERATION
PHASE I

NAME OF DAM: ELK LAKE

NDI ID NO.: PA-01102 DER ID NO.: 64-4

Sheet 1 of 4

ITEM	REMARKS
AS-BUILT DRAWINGS	NONE IN FILES See PLATE E-2 AND E-3.
REGIONAL VICINITY MAP	See PLATE E-1
CONSTRUCTION HISTORY	BUILT CIRCA 1860-1865 FOR FURTHER HISTORY SEE Section 1.
TYPICAL SECTIONS OF DAM	NONE
OUTLETS: Plan Details Constraints Discharge Ratings	Stop Log Notch as shown on PLATE E-3

A-1

ENGINEERING DATA

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	NONE
DESIGN REPORTS	NONE
GEOLOGY REPORTS	NONE
DESIGN COMPUTATIONS: Hydrology and Hydraulics Dam Stability Seepage Studies	NONE
MATERIALS INVESTIGATIONS: Boring Records Laboratory Field	NONE
POSTCONSTRUCTION SURVEYS OF DAM	NONE EXCEPT PROPERTY SURVEYS

ENGINEERING DATA

ITEM	REMARKS
BORROW SOURCES	UNKNOWN
MONITORING SYSTEMS	NONE
MODIFICATIONS	See History in Section 1.
HIGH POOL RECORDS	About an 8" rise in pool during flood of May 1942
POSTCONSTRUCTION ENGINEERING STUDIES AND REPORTS	Pennsylvania Water Supply Commission Report of 1914.
PRIOR ACCIDENTS OR FAILURE OF DAM: Description Reports	NONE

ENGINEERING DATA

ITEM	REMARKS
MAINTENANCE AND OPERATION RECORDS	NONE
SPILLWAY: **Plan** **Sections** **Details**	See PLATE E-3
OPERATING EQUIPMENT: **Plans** **Details**	NONE
PREVIOUS INSPECTIONS **Dates** **Deficiencies**	1924 - SAME CONDITION AS 1914 (see Section 1). "PLANKS in SPILLWAY". 1927 - "GENERAL LEAKAGE THROUGH BASE." SPILLWAY CREST ROUGH & UNEVEN. SETTLEMENT downstream AT both SIDES OF SPILLWAY. 1930 SOME SETTLEMENT ADJOINING SPILLWAY. SOME LEAKAGE below SPILLWAY.
	1933 "1 FT. hole behind LEFT ABUTMENT; ALSO SOME behind RIGHT ABUTMENT AND downstream WALL AT LEFT." ENTIRE FLOW LEAKS THROUGH UNDER THE LOOSE STONES OF SPILLWAY.

4-4

ENGINEERING DATA

ITEM	REMARKS
PREVIOUS INSPECTIONS (CONTINUED)	1938 - SETTLEMENT IN DOWNSTREAM FACE WALL. NO NEW SETTLEMENT. LEAKAGE THROUGH SPILLWAY SECTION.
	1948 - SEVERAL SMALL TREES ON SLOPES. ENTIRE OUTFLOW OF LAKE FLOWS THROUGH THE LOOSE MASONRY OF THE SPILLWAY AND ABUTMENTS.
	LOOSE ROCK FORM AN UNEVEN SPILLWAY CREST. WILLOWS GROWING IN SPILLWAY APPROACH. 1952 - CONSIDERABLE AMOUNT OF BRUSH AND SMALL TREES COVER BOTH
	UPSTREAM AND DOWNSTREAM FACES. CONSIDERABLE LEAKAGE THROUGH BOTH ABUTMENTS AND SPILLWAY PROPER. TREES IN SPILLWAY APPROACH.
	1962 - TREES AND BRUSH OVER MOST FEATURES. SLIGHT LEAKAGE. 1965 - OUTLET CLUTTERED WITH DEBRIS

A-5

APPENDIX B

CHECKLIST - VISUAL INSPECTION

CHECKLIST

VISUAL INSPECTION

PHASE I

Name of Dam: ELK LAKE **County:** WAYNE **State:** PENNSYLVANIA

NDI ID No.: PA-01102 **DER ID No.:** 64-4

Type of Dam: EARTHFILL AND DRY MASONRY **Hazard Category:** HIGH

Date(s) Inspection: JUNE 4 1981 **Weather:** CLEAR **Temperature:** 70's °F

SOIL: MOIST TO WET

Pool Elevation at Time of Inspection: 1419.0 msl/**Tailwater at Time of Inspection:** 1412.3± msl

Inspection Personnel:

R. HOWELL (ELDA) D. WILSON (GFCC)

G. STANTON (ELDA) D. EBERSOLE (GFCC)

N. PHILLIPS (ELDA)

A. WHITMAN (GFCC) **Recorder**

EMBANKMENT

Sheet 1 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	NONE	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	NONE	
SLOUGHING OR EROSION: Embankment Slopes Abutment Slopes	NONE	
CREST ALIGNMENT: Vertical Horizontal	HORIZONTAL - NO deficiencies VERTICAL - SEE PLATES E-2 AND E-3. Composite PROFILE shown in Appendix D.	
RIPRAP FAILURES	NO RIPRAP	

EMBANKMENT

Sheet 2 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT WITH: **Abutment** **Spillway** **Other Features**	3"-4" burrowing animal hole at toe of upstream slope at junction with left end of spillway.	
ANY NOTICEABLE SEEPAGE	None	
STAFF GAGE AND RECORDER	None	
DRAINS	None	
VEGETATION	Grass on Embankment to left in good condition. Brush along dry masonry section. Mature trees on top.	

CONCRETE/MASONRY DAMS

Sheet 1 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	None, but debris at end of spillway chute obscures dry masonry toe.	
JUNCTION OF STRUCTURE WITH: Abutment Embankment Other Features	Some areas near spillway appear to be dry masonry covered with soil.	
DRAINS	None	
WATER PASSAGES	See "Spillway"	
FOUNDATION	Soil with boulders.	

3 1 r

CONCRETE/MASONRY DAMS

Sheet 2 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SURFACES: **Surface Cracks** **Spalling**	Not Applicable	
STRUCTURAL CRACKING	Not Applicable	To left and right of spillway opening, dry masonry is bulged; obviously not of recent origin.
ALIGNMENT: **Vertical** **Horizontal**	See Plates E-2 and E-3	
MONOLITH JOINTS	Not Applicable	
CONSTRUCTION JOINTS	Not Applicable	Two slots, as shown on Exhibit B-1, just downstream of bridge, left slot is blocked by stone/soil. Right slot is open, remains of timber within.
STAFF GAGE OR RECORDER	None	

B-5

OUTLET WORKS

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Not Applicable	
INTAKE STRUCTURE	Stoplog slot in spillway weir.	Good Condition
OUTLET STRUCTURE	Spillway chute.	
OUTLET CHANNEL	Spillway chute.	
EMERGENCY GATE	Wooden Stoplog	

UNGATED SPILLWAY

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	GOOD CONDITION	
APPROACH CHANNEL	RESERVOIR	
DISCHARGE CHANNEL	CONCRETE AND DRY MASONRY LINED CHUTE THROUGH DRY MASONRY DAM	
BRIDGE AND PIERS	NO PIERS CONCRETE FOOTBRIDGE IN GOOD CONDITION.	

INSTRUMENTATION

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	NONE AT SITE	
OBSERVATION WELLS		
WEIRS		
PIEZOMETERS		
OTHER	NONE AT SITE	

DOWNSTREAM CHANNEL

Sheet 1 of 1

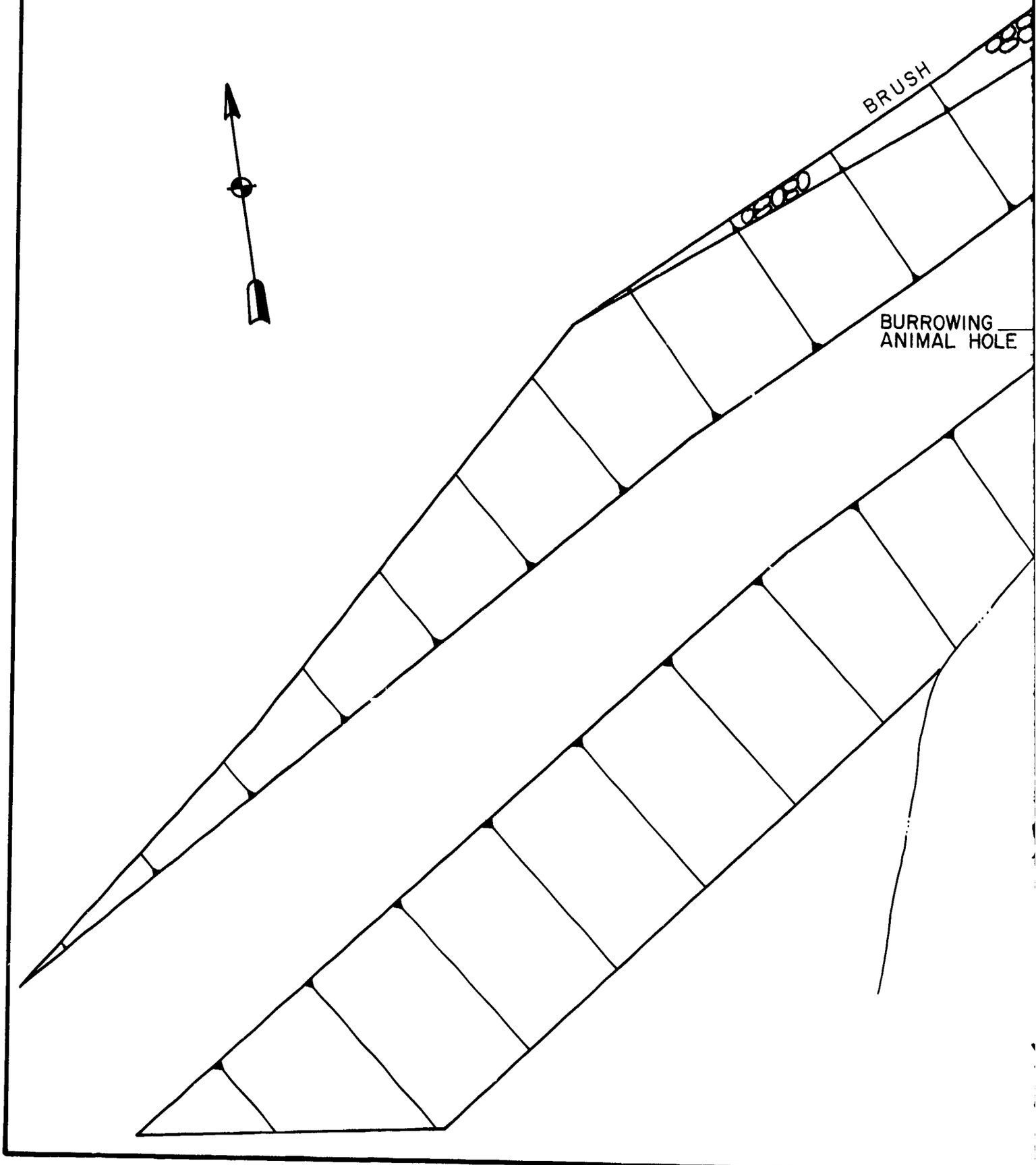
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION: **Obstructions** **Debris** **Other**	Debris rises from bottom of dam to invert of spillway chute.	Existing debris would not reduce spillway capacity.
SLOPES	Steep at damsite.	
APPROXIMATE NUMBER OF HOMES AND POPULATION	2 mobile homes immediately downstream of embankment to left of spillway.	Little Keen Pond Dam and Keen Lake Dam downstream - see Appendix D.

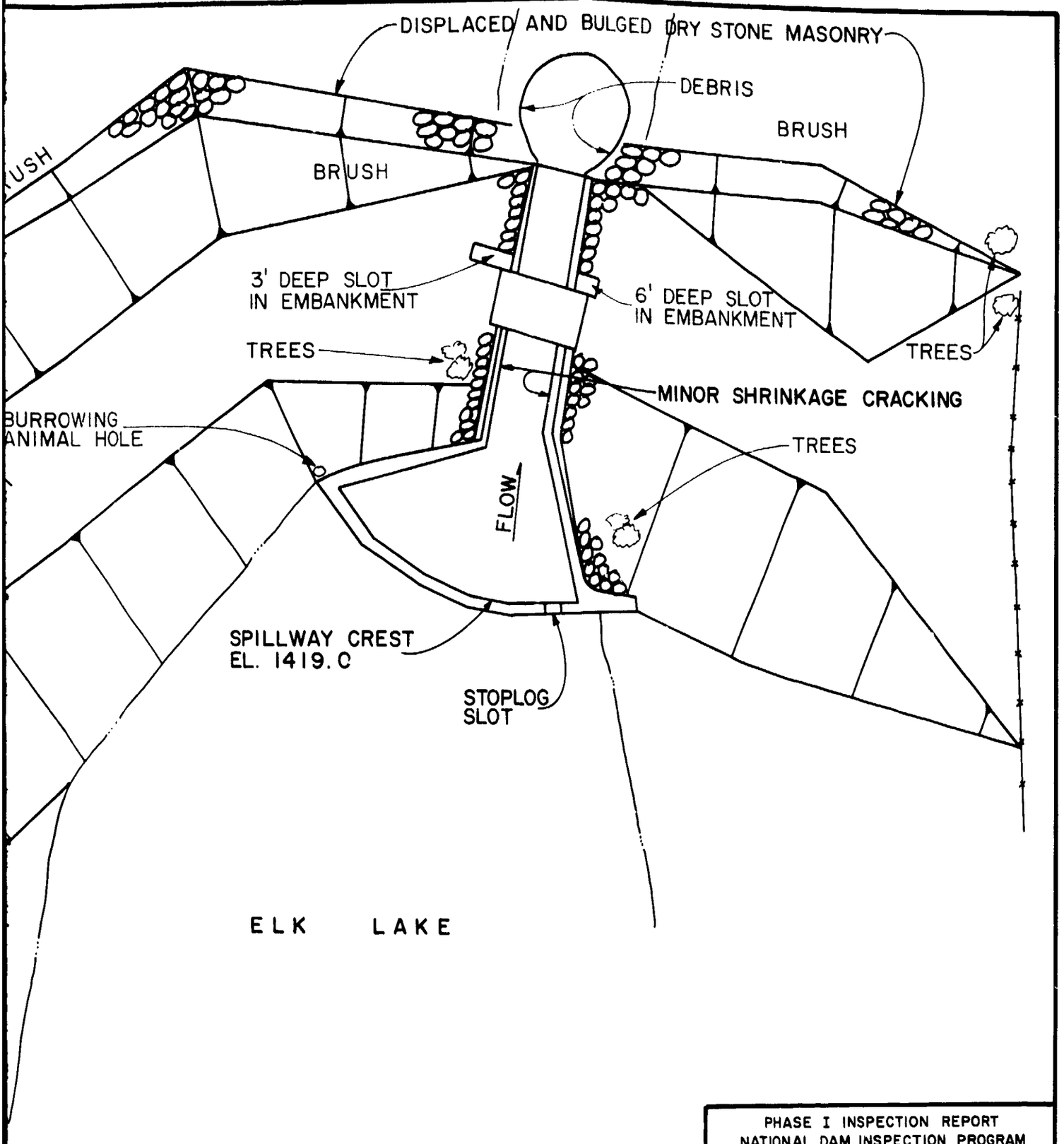
RESERVOIR AND WATERSHED

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	GENERALLY MILD	
SEDIMENTATION	NO REPORTED PROBLEMS UPSTREAM SLOPE OF DAM IS VERY FLAT.	
WATERSHED DESCRIPTION	WOODLAND AND MEADOW EXCEPT FOR DEVELOPMENT AROUND LAKE.	

DATE OF INSPECTION: 4 JUNE 1981
POOL ELEVATION: 1419.0





PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

ELK LAKE DAM

ELK LAKE DEVELOPMENT
ASSOCIATION, INC.

RESULTS OF VISUAL INSPECTION

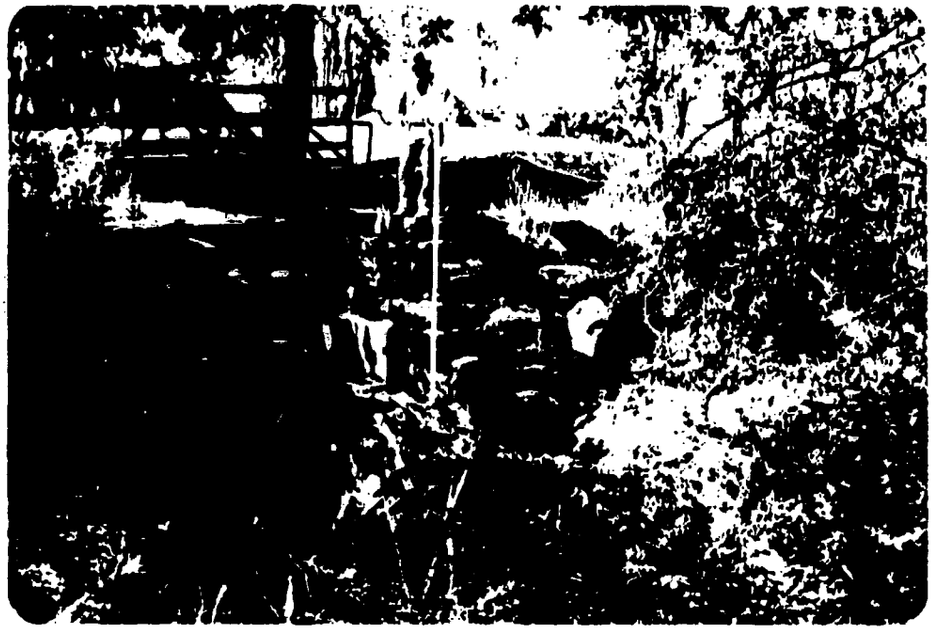
JULY 1981 EXHIBIT B-1

2

APPENDIX C

PHOTOGRAPHS

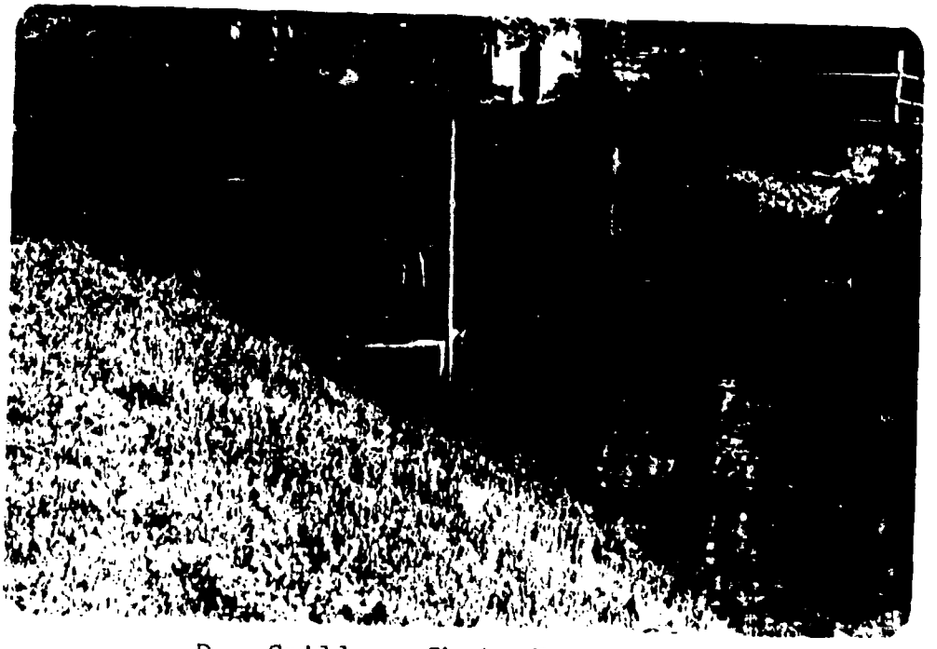
ELK LAKE DAM



A. Dry Masonry Section and Spillway Chute

B. Dry Masonry Section

C. Spillway Weir



D. Spillway Chute Entrance

ELK LAKE DAM

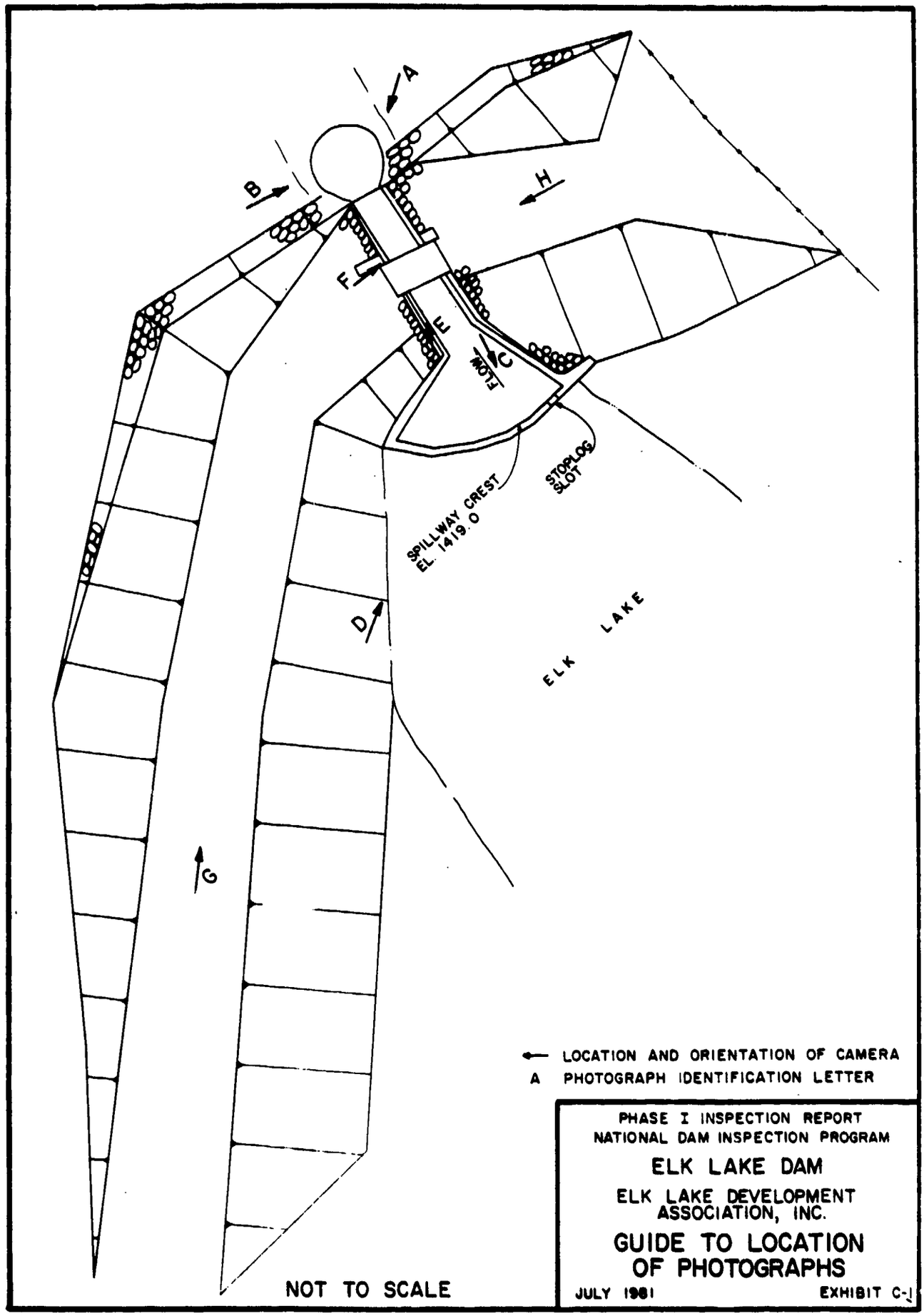
E. Spillway Chute

F. Opening In Dry Masonry By Spillway Chute

ELK LAKE DAM

G. Embankment Left of Spillway

H. Spillway Bridge



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

ELK LAKE DAM

ELK LAKE DEVELOPMENT
ASSOCIATION, INC.

GUIDE TO LOCATION OF PHOTOGRAPHS

JULY 1981 EXHIBIT C-1

APPENDIX D

HYDROLOGY AND HYDRAULICS

APPENDIX D

HYDROLOGY AND HYDRAULICS

Spillway Capacity Rating:

In the recommended Guidelines for Safety Inspection of Dams, the Department of the Army, Office of the Chief of Engineers (OCE), established criteria for rating the capacity of spillways. The recommended Spillway Design Flood (SDF) for the size (small, intermediate, or large) and hazard potential (low, significant, or high) classification of a dam is selected in accordance with the criteria. The SDF for those dams in the high hazard category varies between one-half of the Probable Maximum Flood (PMF) and the PMF. If the dam and spillway are not capable of passing the SDF without overtopping failure, the spillway capacity is rated as inadequate. If the dam and spillway are capable of passing one-half of the PMF without overtopping failure, or if the dam is not in the high hazard category, the spillway capacity is not rated as seriously inadequate. A spillway capacity is rated as seriously inadequate if all of the following conditions exist:

(a) There is a high hazard to loss of life from large flows downstream of the dam.

(b) Dam failure resulting from overtopping would significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure.

(c) The dam and spillway are not capable of passing one-half of the PMF without overtopping failure.

Description of Model:

If the Owner has not developed a PMF for the dam, the watershed is modeled with the HEC-1DB computer program, which was developed by the U.S. Army Corps of Engineers. The HEC-1DB computer program calculates a PMF runoff hydrograph (and percentages thereof) and routes the flows through both reservoirs and stream sections. In addition, it has the capability to simulate an overtopping dam failure. By modifying the rainfall criteria, it is also possible to model the 100-year flood with the program.

APPENDIX D

DELAWARE River Basin
Name of Stream: ELK LAKE RUN
Name of Dam: ELK LAKE
NDI ID No.: PA - 01102
DER ID No.: 64-4
Latitude: N 41° 37.7' Longitude: W 75° 23.4'
Top of Dam Elevation: 1423.1
Streambed Elevation: 1413.3 Height of Dam: 10.8 ft
Reservoir Storage at Top of Dam Elevation: 3220 acre-ft
Size Category: INTERMEDIATE
Hazard Category: HIGH (see Section 5)
Spillway Design Flood: PMF

UPSTREAM DAMS

Name	Distance from Dam (miles)	Height (ft)	Storage at top of Dam Elevation (acre-ft)	Remarks
	NONE			

DOWNSTREAM DAMS

LITTLE KEEN POND *	3.7	12	409	
KEEN LAKE *	4.0	26	1449	DER ID 64-13 NDI PA-00092

* HEIGHT AND STORAGE DATA FROM PHASE I REPORT FOR KEEN LAKE DAM.

DELAWARE River Basin

Name of Stream: ELK LAKE RUN

Name of Dam: ELK LAKE

DETERMINATION OF PMF RAINFALL & UNIT HYDROGRAPH

UNIT HYDROGRAPH DATA:

Sub-area	Drainage Area (square miles)	Cp (1)	Ct (2)	L miles (3)	L_{ca} miles (4)	L' miles (5)	Tp hours (6)	Map Area (7)	Plate (8)
A	0.93	0.45	1.23	N/A	N/A	0.68	0.98	1	A
Total	0.93								

(See Sketch on Sheet D-4)

(1) & (2): Snyder Unit Hydrograph coefficients supplied by Baltimore District, Corps of Engineers on maps and plates referenced in (7) & (8)

The following are measured from the outlet of the subarea:

(3): Length of main watercourse extended to divide

(4): Length of main watercourse to the centroid

The following is measured from the upstream end of the reservoir at normal pool:

(5): Length of main watercourse extended to divide

(6): $Tp=C_t \times (L \times L_{ca})^{0.3}$, except where the centroid of the subarea is located in the reservoir. Then $Tp=C_t \times (L')^{0.6}$

Initial flow is assumed at 1.5 cfs/sq. mile

Computer Data: QRCSN = -0.05 (5% of peak flow)
RTIOR = 2.0

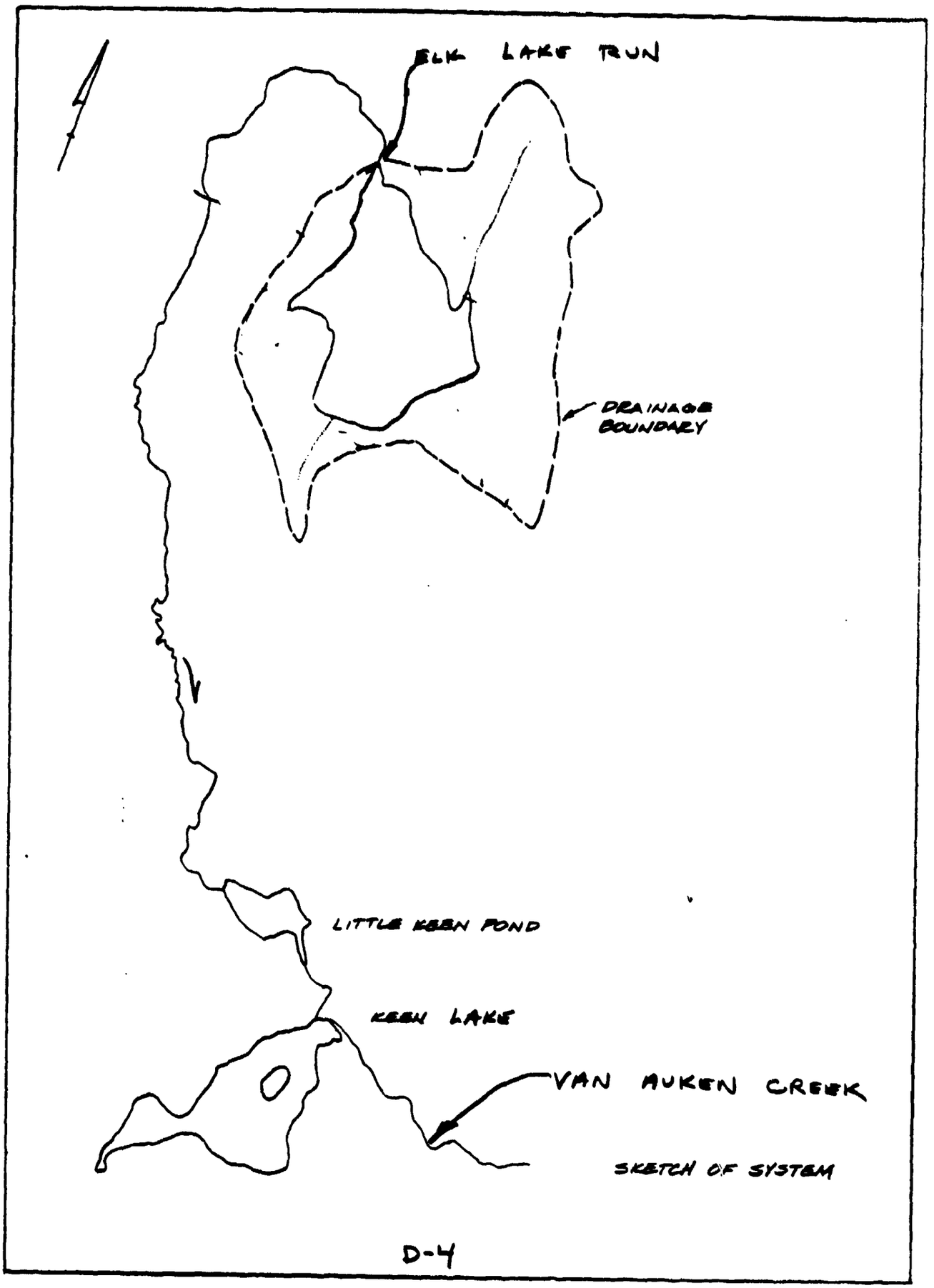
RAINFALL DATA:

PMF Rainfall Index= 21.2 in., 200 sq. mile

	Hydromet. 40 (Susquehanna Basin)	Hydromet. 33 (Other Basins)
Zone:	N/A	1
Geographic Adjustment Factor:		1.0
Revised Index Rainfall:		21.2

RAINFALL DISTRIBUTION (percent)

Time	Percent
6 hours	111
12 hours	123
24 hours	133
48 hours	142
72 hours	N/A
96 hours	N/A


ELK LAKE RUN
DRAINAGE BOUNDARY
LITTLE KEEN POND
KEEN LAKE
VAN AUKEN CREEK
SKETCH OF SYSTEM

Data for Dam at Outlet of Subarea A (See sketch on Sheet D-4)

Name of Dam: ELK LAKE

STORAGE DATA:

Elevation		Area (acres)	Storage million gals	Storage acre-ft	Remarks
1371	=ELEVO*	0	0	0	BASED ON REPORTED DEPTH DATA IN FILES. STREAMBED AT TOE
1412.3		113		1559 =S1	
1415	=ELEV1	133 =A1		2448	SPILL CREST
1420		188			
1423.1		200		3220	TOP DAM
1440	**	273			

* ~~ELEVO = ELEV1 = (38/A1)~~ $S_1 = A_1 (ELEV1 - ELEVO)/3$

** Planimetered contour at least 10 feet above top of dam

Reservoir Area at Normal Pool is 26 percent of subarea watershed.

BREACH DATA: Not Used

See Appendix B for sections and existing profile of the dam.

Soil Type from Visual Inspection: _____

Maximum Permissible Velocity (Plate 28, EM 1110-2-1601) _____ fps
(from $Q = CLH^{3/2} = V \cdot A$ and depth = (2/3) x H) & A = L·depth

HMAX = $(4/9\ V^2/C^2)$ = _____ ft., C = ____ Top of Dam El.= ____

HMAX + Top of Dam El. = _____ = FAILEL
(Above is elevation at which failure would start)

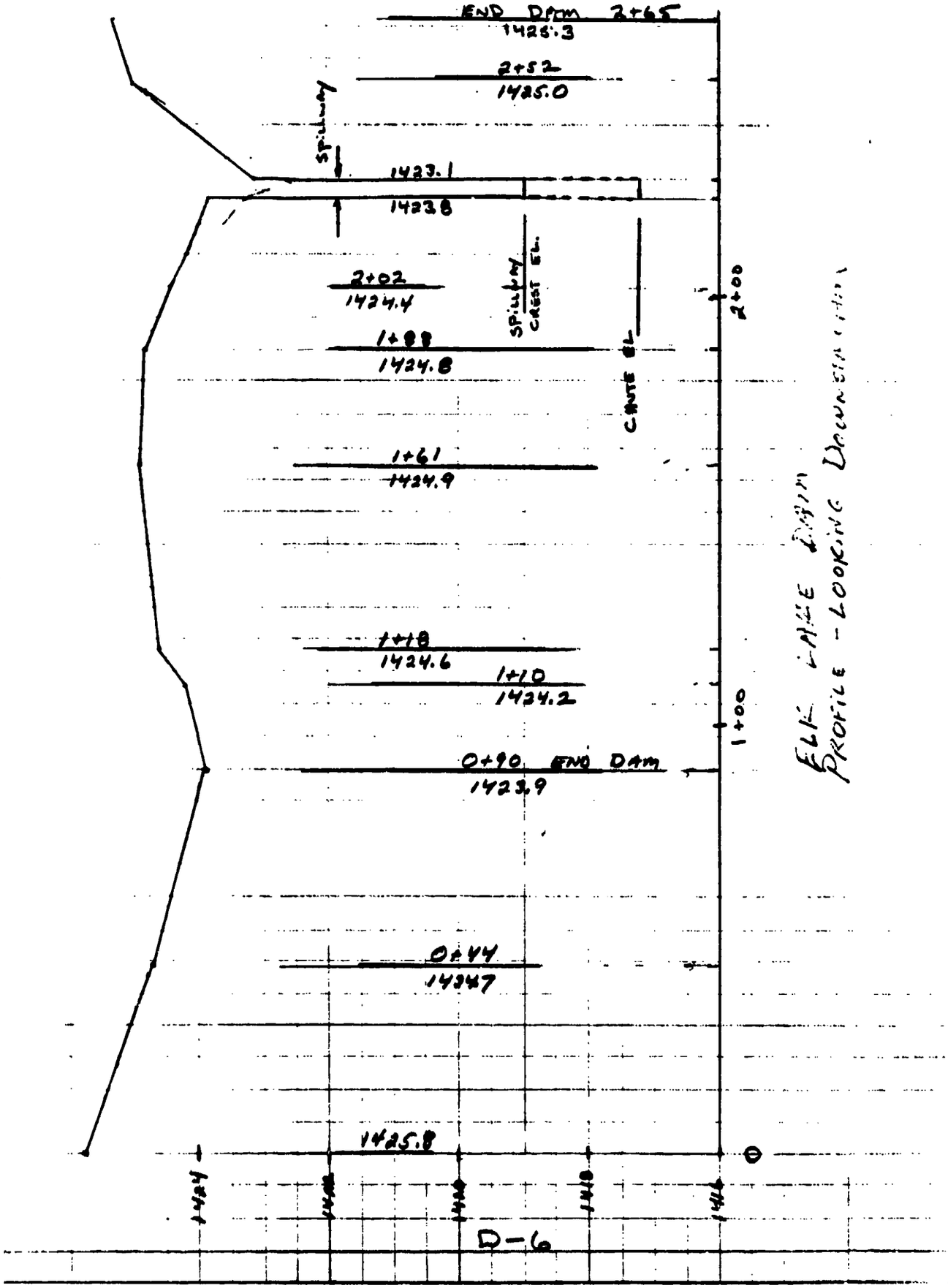
Dam Breach Data:

BRWID = _____ ft (width of bottom of breach)
Z = _____ (side slopes of breach)
ELBM = _____ (bottom of breach elevation, minimum of zero storage elevation)
WSEL = _____ (normal pool elevation)
T FAIL = _____ mins = _____ hrs (time for breach to develop)

BY _____ DATE _____
CHKD. BY _____ DATE _____

SUBJECT ELK LAKE DAM

SHEET NO. _____ OF _____
JOB. NO. _____



ELK LAKE DAM
PROFILE - LOOKING DOWNSTREAM

BY _____ DATE _____ SUBJECT _____ SHEET NO. _____ OF _____

CHKD. BY _____ DATE _____ JOB. NO. _____

Spillway Capacity
Elk Lake Dam

Control will initially be at the weir, EL 1419.0
Control will probably shift to the chute.

The effective weir length is
$5.2 + 4.0 + 4.0 + 4.1 + 5.0 = 22.3' = L$

Similar to Figure 77 Chapter 5 of King's Hand book

$Q = C L H^{3/2}$ H = head = (Pool − weir elev)

Pool	H (ft)	C (Kings Handbook)	Q (cfs)
1419	0	3.53	0
1419.5	0.5	3.53	28
1420.0	1.0	3.54	79
1420.5	1.5	3.55	145
1421.0	2.0	3.50	221
1421.5	2.5	3.35	295
1422.0	3.0	3.27	379
1422.5	3.5	3.25	475
1423.0	4.0	}	580
1423.5	4.5	}	692
1424.0	5.0	3.25	810

BY _____ DATE _____ SUBJECT ELK LAKE DAM SHEET NO. _____ OF _____

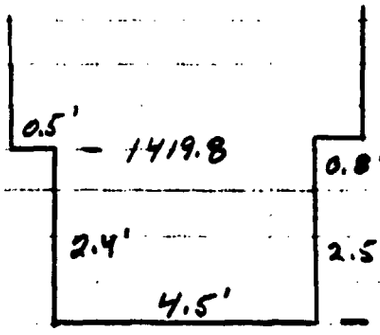
CHKD BY _____ DATE _____ JOB. NO. _____

At the spillway chute

$$\frac{A^3}{T} = \frac{Q^2}{g} \qquad hv = \frac{Q^2}{2gA^2}$$

A = AREA T = TOPWIDTH

Pool = depth + 1417.4 + hv



$Q = \sqrt{h^3 \frac{g}{T}}$

$(d-2.4) \times .5$
$+ (d-2.5) \times .8$
$+ d \times 4.5$

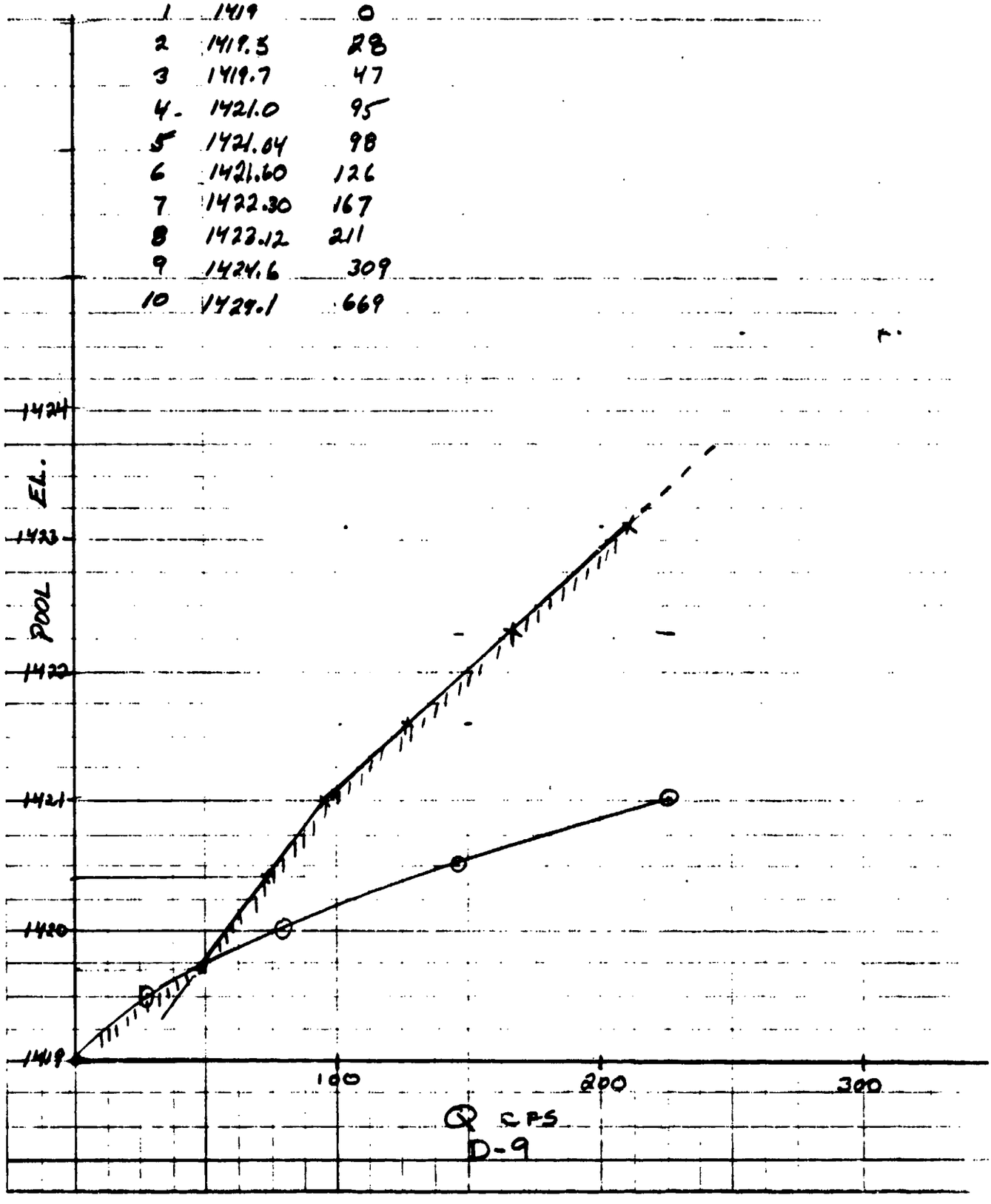
depth	T	A	Q	hv	Pool	
0	4.5	0	0	0	1417.4	
1	4.5	4.5	26	0.5	1418.9	
1.5	4.5	6.75	47	0.75	1419.7	
2.0	4.5	9.0	72	1.00	1420.4	
2.4	4.5	10.8	95	1.20	1421.0	
2.5	5.0	11.3	96	1.13	1421.03	
2.6	5.8	12.03	98	1.04	1421.04	
3.0	5.8	14.20	126	1.22	1421.60	
3.5	5.8	17.10	167	1.47	1422.30	
4.0	5.8	20.0	211	1.72	1423.12	Top dam
4.5	5.8	22.9	258	1.97	1423.9	
5.0	5.8	25.8	309	2.22	1424.6	
8.0	5.8	43.2	669	3.72	1429.1	

BY _____ DATE _____ SUBJECT ELK LAKE DAM SHEET NO. _____ OF _____

CHKD. BY _____ DATE _____ JOB. NO. _____

SELECTED OUTFLOW CURVE

	ELEV	Q
1	1419	0
2	1419.5	28
3	1419.7	47
4	1421.0	95
5	1421.04	98
6	1421.60	126
7	1422.30	167
8	1423.12	211
9	1424.6	309
10	1429.1	669



D-9

BY _____ DATE _____ SUBJECT _____ SHEET NO. _____ OF _____

CHKD. BY _____ DATE _____ JOB. NO. _____

Selected Computer Output

INDEX

ITEM	PAGE
INPUT	D-11
SUMMARY OF PEAK FLOWS	D-12
ELIC LAKE DAM	D-13

```
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
```

```
    1                A1                              NATIONAL DAM INSPECTION PROGRAM
    2                A2                                      ELK LAKE RUN
    3                A3                                      ELK LAKE DAM
    4                B     300        0       15        0        0        0        0        0       -4        0
    5                B1      5
    6                J       1        9        1
    7                J1      1       .9       .8       .7       .6       .5       .4       .3       .2
    8                K                1                                          1
    9                K1        RUNOFF INTO ELK LAKE
   10                M       1        1      .93                .93                                  1
   11                P                21.2      111      123      133      142
   12                T                                                           1.0      .05                .26
   13                W     .98      .45
   14                X    -1.5     -.05      2.0
   15                K       1        1                                          1
   16                K1        ROUTE THROUGH ELK LAKE DAM
   17                Y                                 1        1
   18                Y1      1                                                -1419.0       -1
   19                Y61419.0  1419.5   1419.7   1421.0  1421.04   1421.6   1422.3  1423.12   1424.6   1429.1
   20                Y5      0       28       47       95       98      126      167      211      305      669
   21                SA      0      153      188      273
   22                SE   1371     1419     1420     1460
   23                SS1419.0
   24                SD1423.1
   25                SL      0        9       12       61      112      142      155      212      239
   26                SV1423.1  1423.8   1423.9   1424.2   1424.6   1424.7   1424.8   1425.0   1425.3
   27                K      99
```

D-1

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS								
				RATIO 1 1.00	RATIO 2 .90	RATIO 3 .80	RATIO 4 .70	RATIO 5 .60	RATIO 6 .50	RATIO 7 .40	RATIO 8 .30	RATIO 9 .20
HYDROGRAPH AT	1	.93	1	2635.	2371.	2108.	1844.	1581.	1317.	1054.	790.	527.
	(	2.41)	(	74.61)(	67.15)(	59.69)(	52.23)(	44.77)(	37.31)(	29.84)(	22.38)(	14.92)
ROUTED TO	1	.93	1	263.	228.	199.	175.	148.	121.	97.	78.	59.
	(	2.41)	(	7.44)(	6.44)(	5.65)(	4.94)(	4.19)(	3.43)(	2.74)(	2.20)(	1.68)

D-12

SUMMARY OF DAM SAFETY ANALYSIS

ELK LAKE DAM

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1419.00	1419.00	1423.10
STORAGE	2448.	2448.	3220.
OUTFLOW	0.	0.	210.

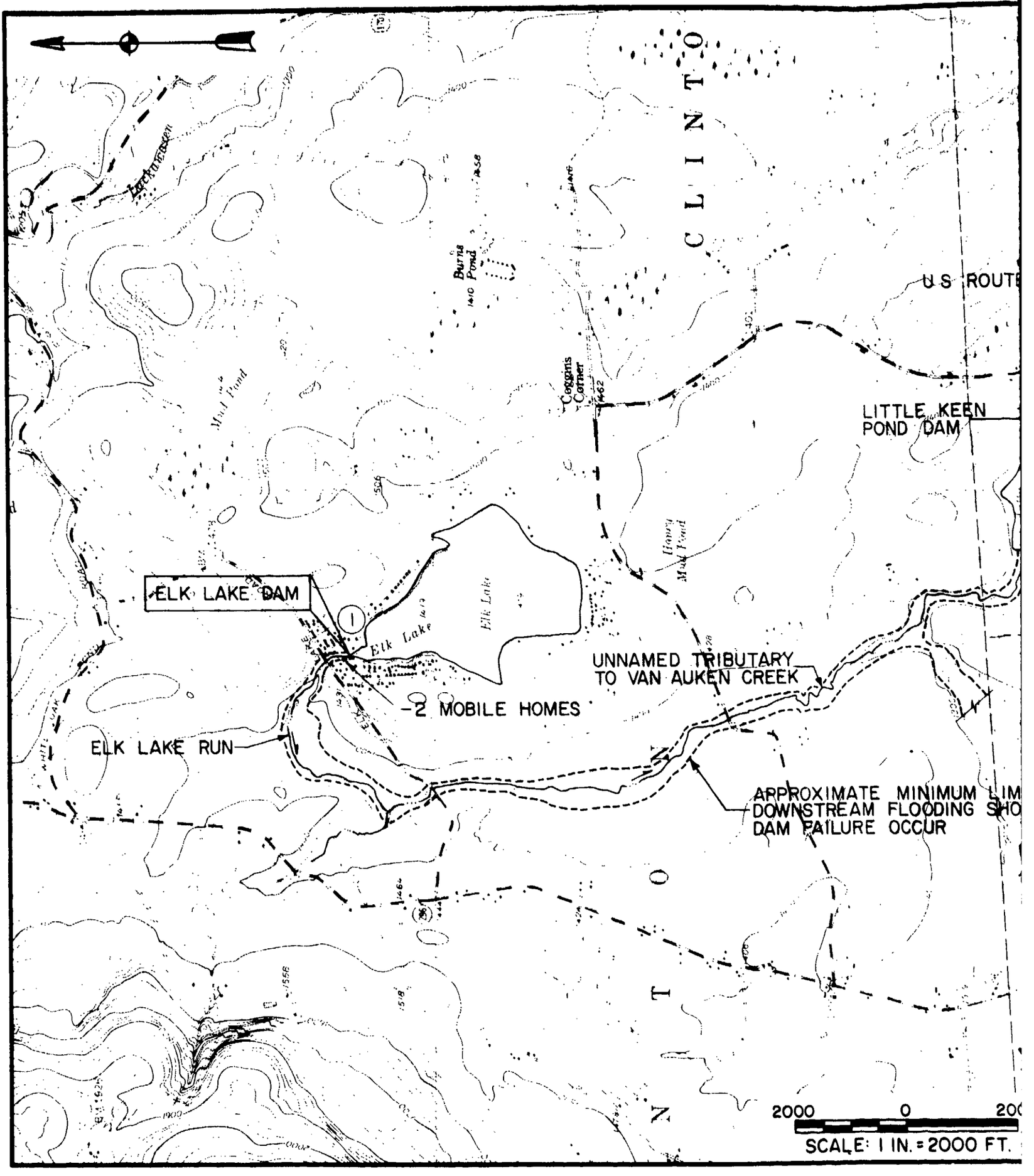
RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1423.81	.71	3362.	263.	13.75	45.75	0.00
.90	1423.36	.26	3272.	228.	8.00	46.00	0.00
.80	1422.90	0.00	3181.	199.	0.00	46.00	0.00
.70	1422.44	0.00	3089.	175.	0.00	46.00	0.00
.60	1421.98	0.00	2997.	148.	0.00	46.00	0.00
.50	1421.50	0.00	2905.	121.	0.00	46.00	0.00
.40	1421.02	0.00	2813.	97.	0.00	46.00	0.00
.30	1420.53	0.00	2719.	78.	0.00	45.75	0.00
.20	1420.04	0.00	2625.	59.	0.00	45.50	0.00

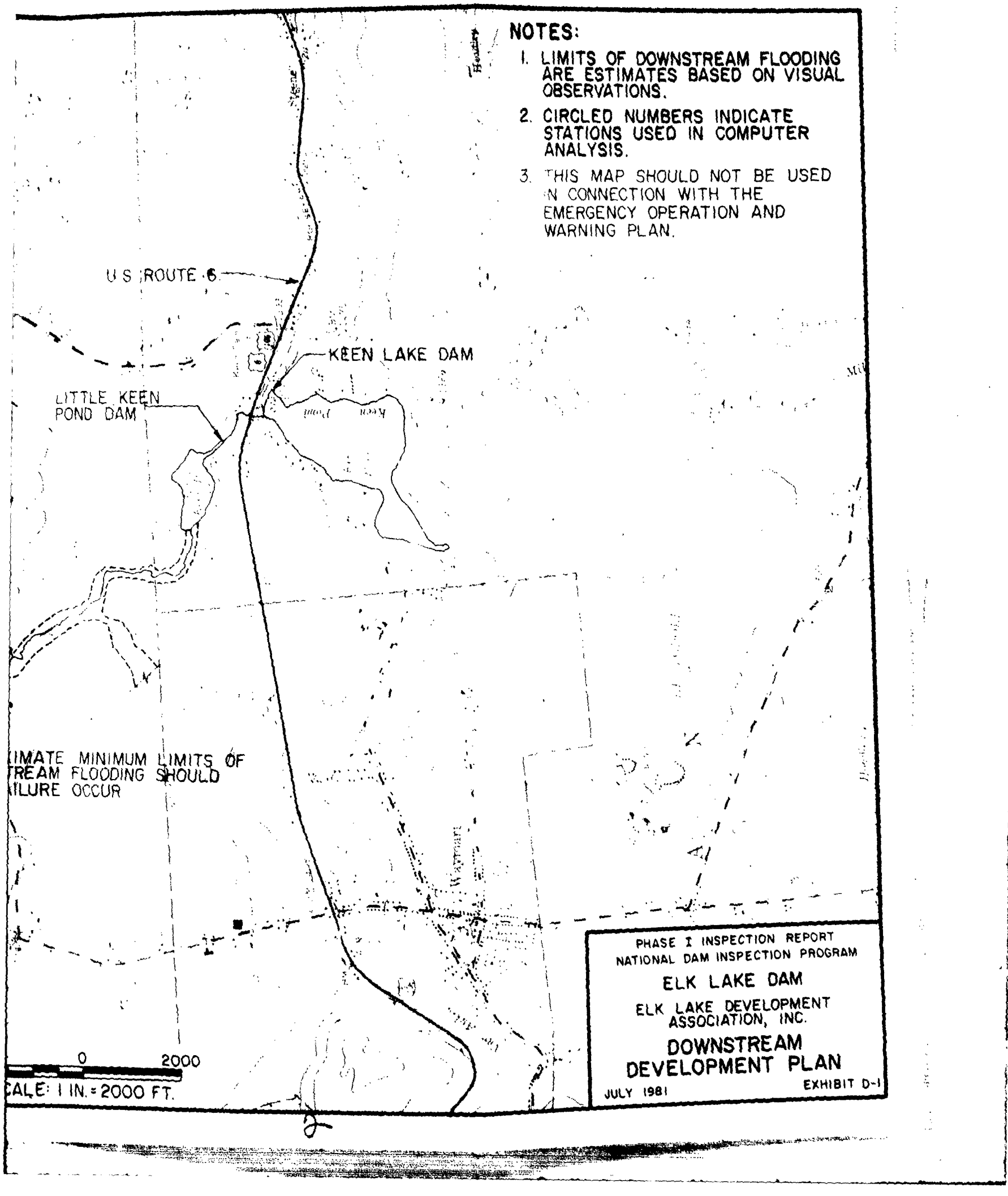
BY _____ DATE _____ SUBJECT _____ SHEET NO. _____ OF _____

CHKD. BY _____ DATE _____ JOB. NO. _____

Summary of Pertinent Results

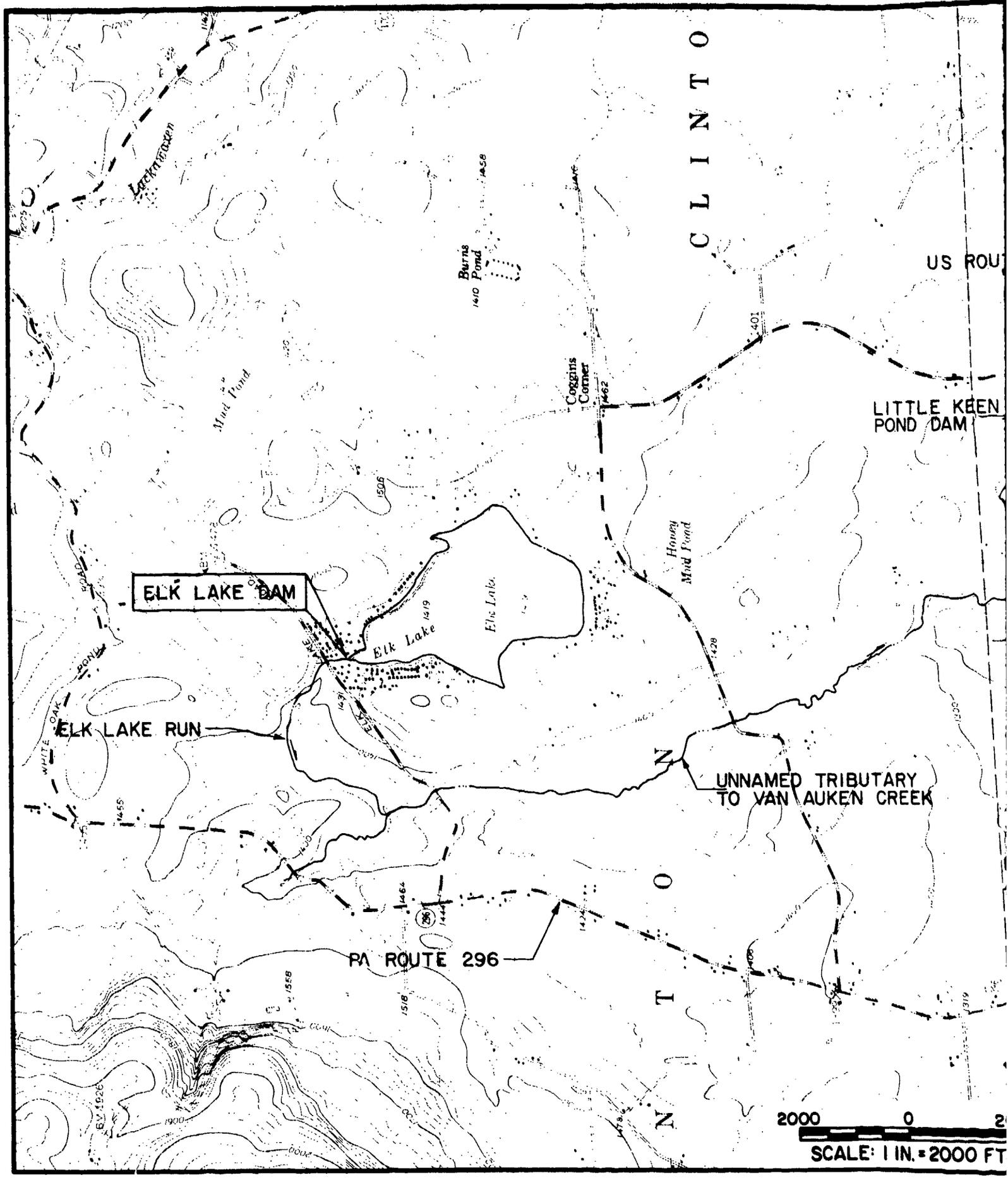
	PMF = SDF	½ PMF
Rainfall (inches)	24.08	
Runoff (inches)	22.32	11.16
Peak Inflow (cfs)	2,635	1,317
Peak Outflow (cfs)	263	121
Depth of Overtopping (ft.)	.71	—
Duration of Overtopping (hrs)	13.75	—

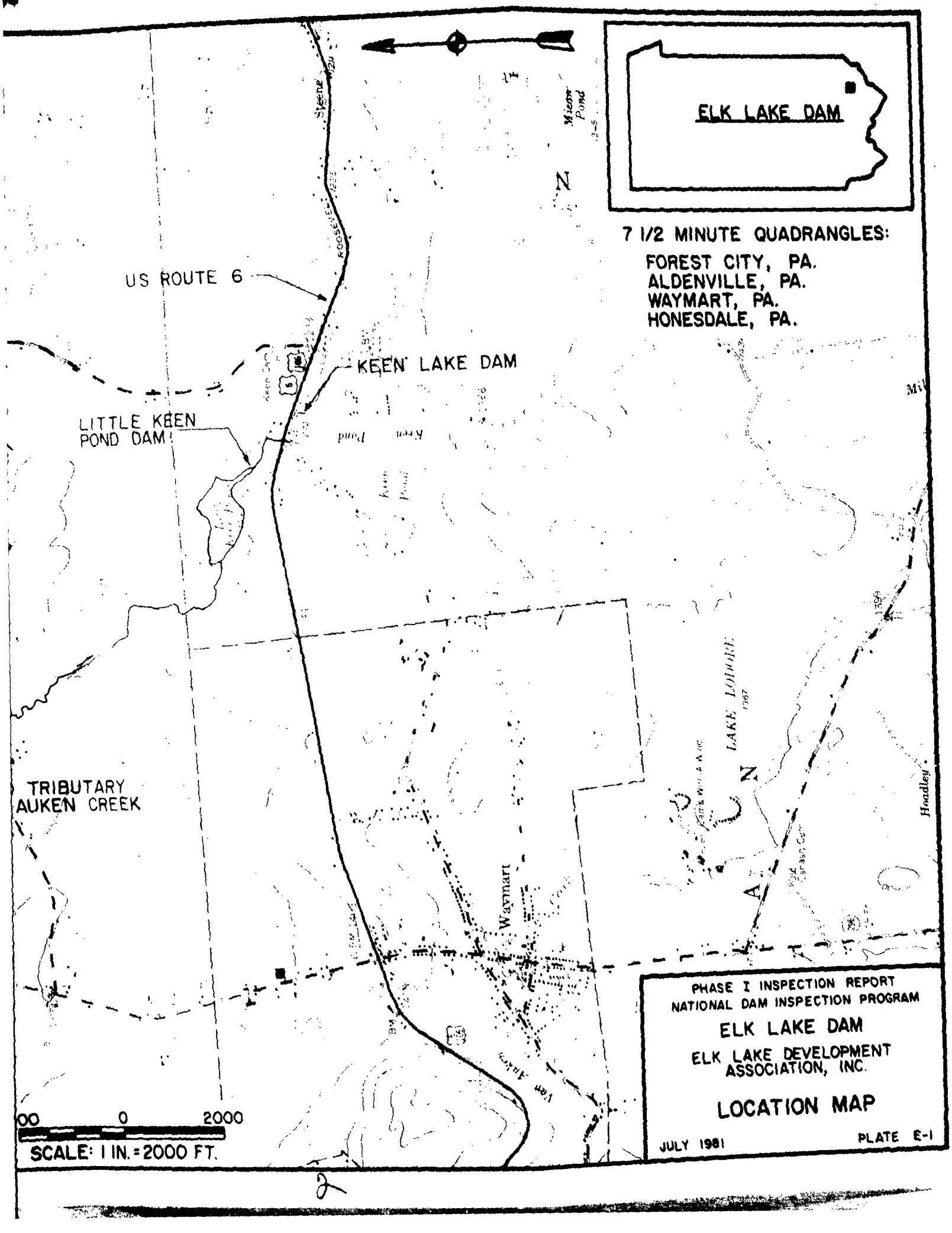

CLINTON
U S ROUTE
LITTLE KEEN
POND DAM
ELK LAKE DAM
UNNAMED TRIBUTARY
TO VAN AUKEN CREEK
2 MOBILE HOMES
ELK LAKE RUN
APPROXIMATE MINIMUM LIM
DOWNSTREAM FLOODING SHO
DAM FAILURE OCCUR
Elk Lake
Burns Pond
Coggins Corner
Mud Pond
Honey Mud Pond
2000
0
SCALE: 1 IN. = 2000 FT.


NOTES:
1. LIMITS OF DOWNSTREAM FLOODING ARE ESTIMATES BASED ON VISUAL OBSERVATIONS.
2. CIRCLED NUMBERS INDICATE STATIONS USED IN COMPUTER ANALYSIS.
3. THIS MAP SHOULD NOT BE USED IN CONNECTION WITH THE EMERGENCY OPERATION AND WARNING PLAN.
U S ROUTE 6
KEEN LAKE DAM
LITTLE KEEN POND DAM
IMATE MINIMUM LIMITS OF
REAM FLOODING SHOULD
ILURE OCCUR
0
2000
CALE: 1 IN. = 2000 FT.
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
ELK LAKE DAM
ELK LAKE DEVELOPMENT ASSOCIATION, INC.
DOWNSTREAM DEVELOPMENT PLAN
JULY 1981
EXHIBIT D-1

APPENDIX E

PLATES


ELK LAKE DAM
ELK LAKE RUN
PA ROUTE 296
UNNAMED TRIBUTARY
TO VAN AUKEN CREEK
LITTLE KEEN
POND DAM
US ROU
CLINTO
N
Elk Lake
Mud Pond
Burns Pond
Coggins Corner
Honey Mud Pond
WHITE OAK POND
2000 0
SCALE: 1 IN. = 2000 FT


ELK LAKE DAM
7 1/2 MINUTE QUADRANGLES:
FOREST CITY, PA.
ALDENVILLE, PA.
WAYMART, PA.
HONESDALE, PA.
US ROUTE 6
KEEN LAKE DAM
LITTLE KEEN POND DAM
TRIBUTARY AUKEN CREEK
Waymart
LAKE LOUISE
Hoadley
SCALE: 1 IN. = 2000 FT.
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
ELK LAKE DAM
ELK LAKE DEVELOPMENT ASSOCIATION, INC.
LOCATION MAP
JULY 1981
PLATE E-1

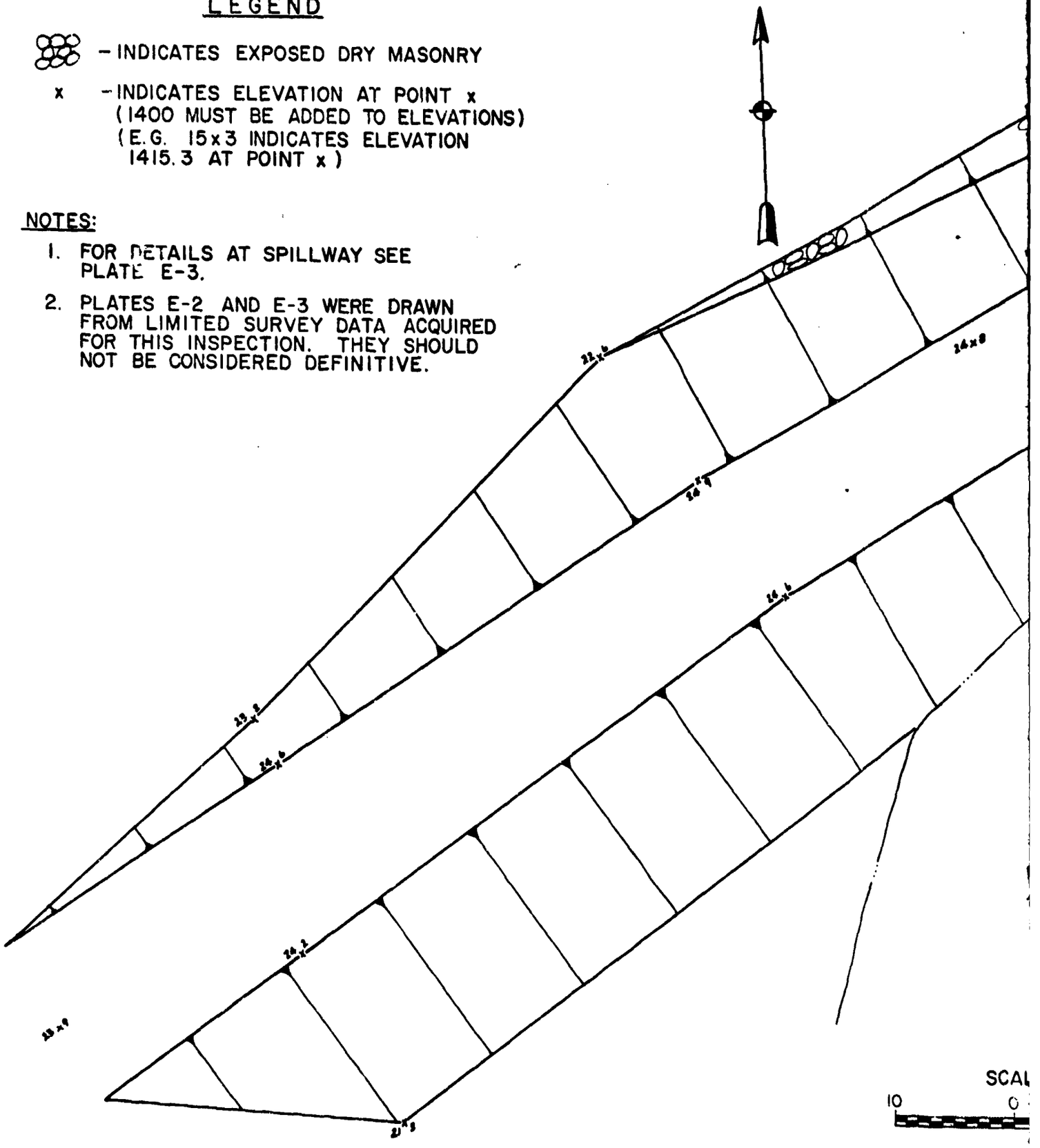
LEGEND

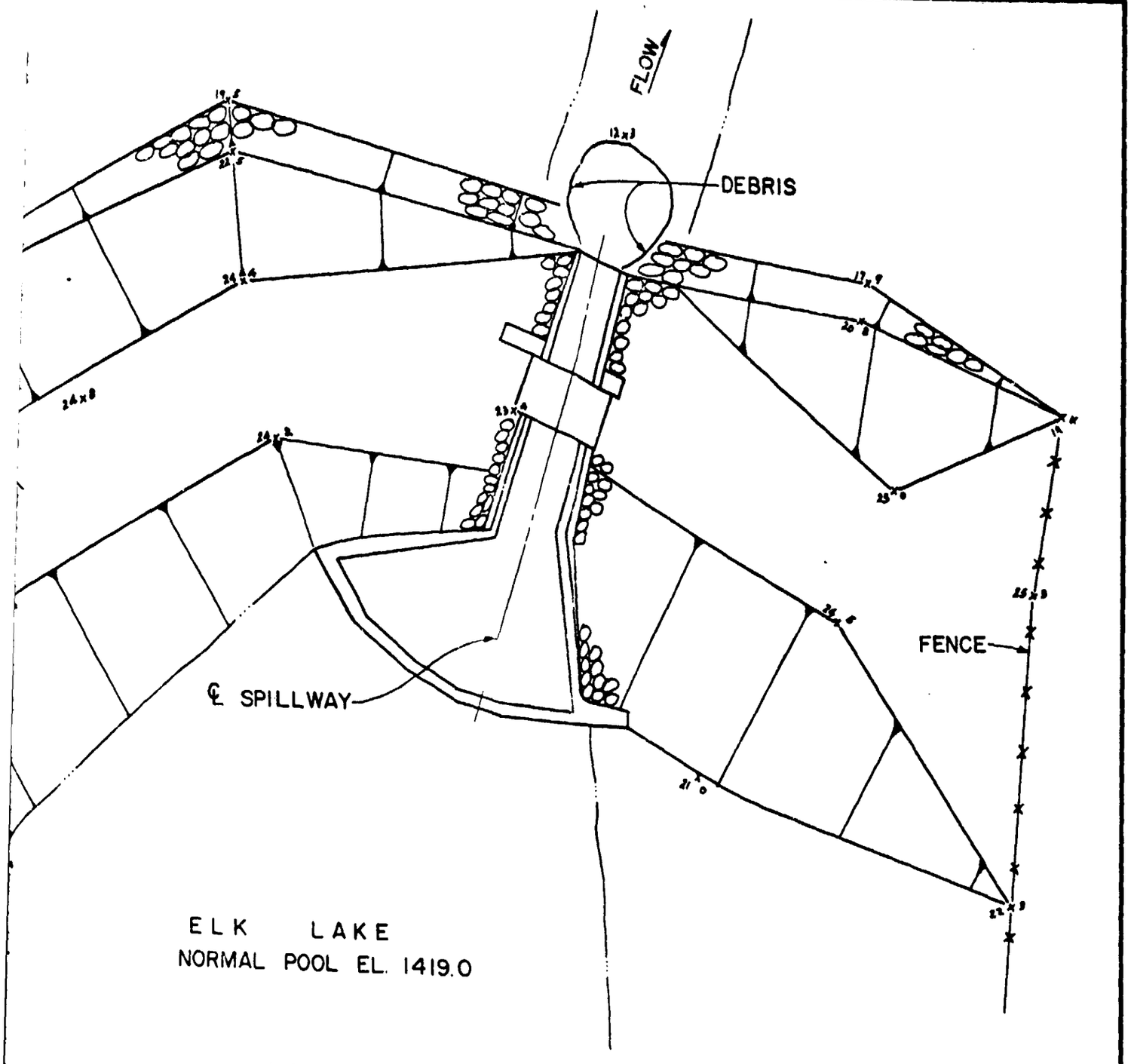
- INDICATES EXPOSED DRY MASONRY

x - INDICATES ELEVATION AT POINT x
(1400 MUST BE ADDED TO ELEVATIONS)
(E.G. 15x3 INDICATES ELEVATION
1415.3 AT POINT x)

NOTES:

1. FOR DETAILS AT SPILLWAY SEE PLATE E-3.
2. PLATES E-2 AND E-3 WERE DRAWN FROM LIMITED SURVEY DATA ACQUIRED FOR THIS INSPECTION. THEY SHOULD NOT BE CONSIDERED DEFINITIVE.





SCALE: 1 IN. = 10 FT.

0 10 20

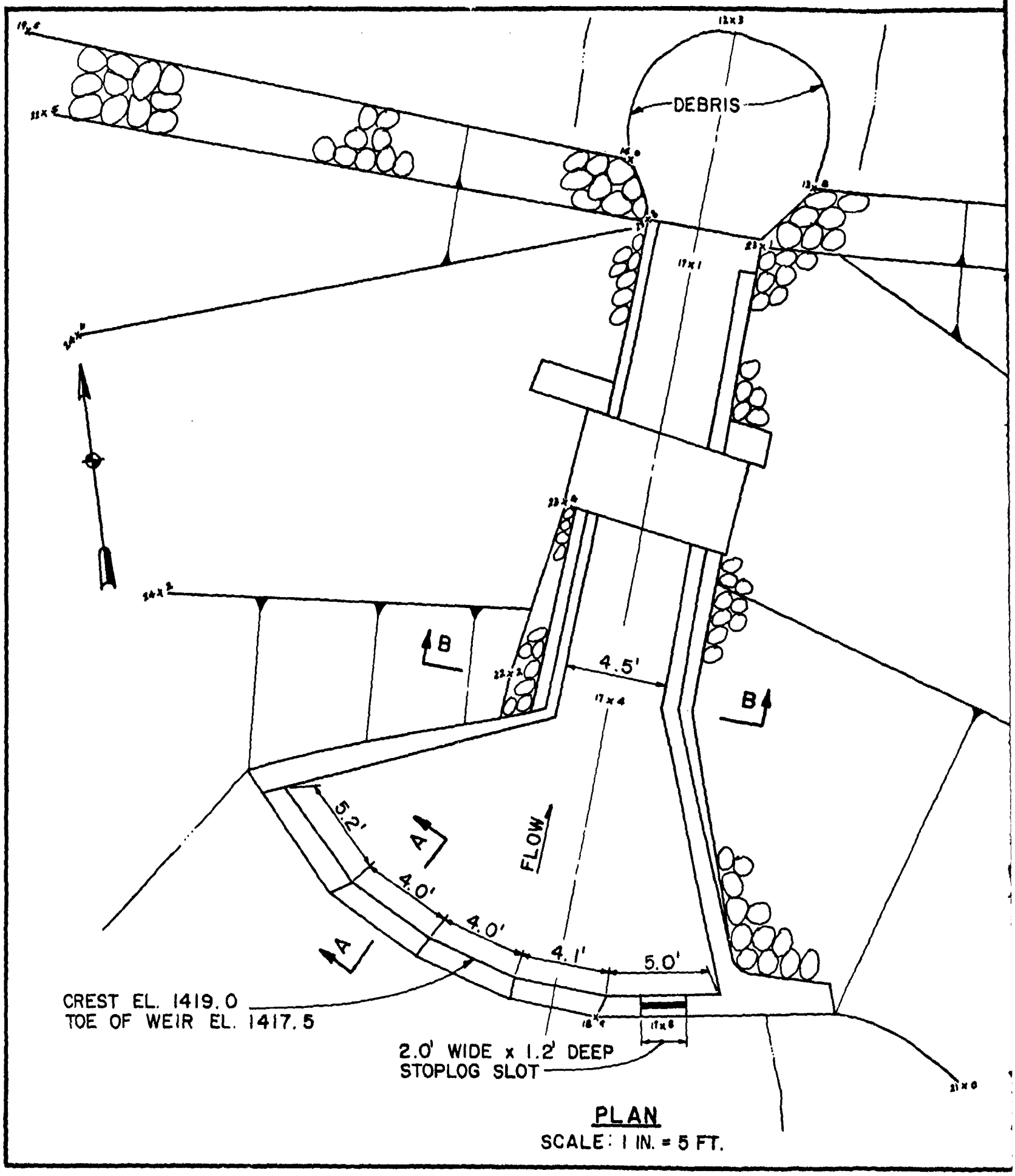
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

ELK LAKE DAM

ELK LAKE DEVELOPMENT ASSOCIATION, INC.

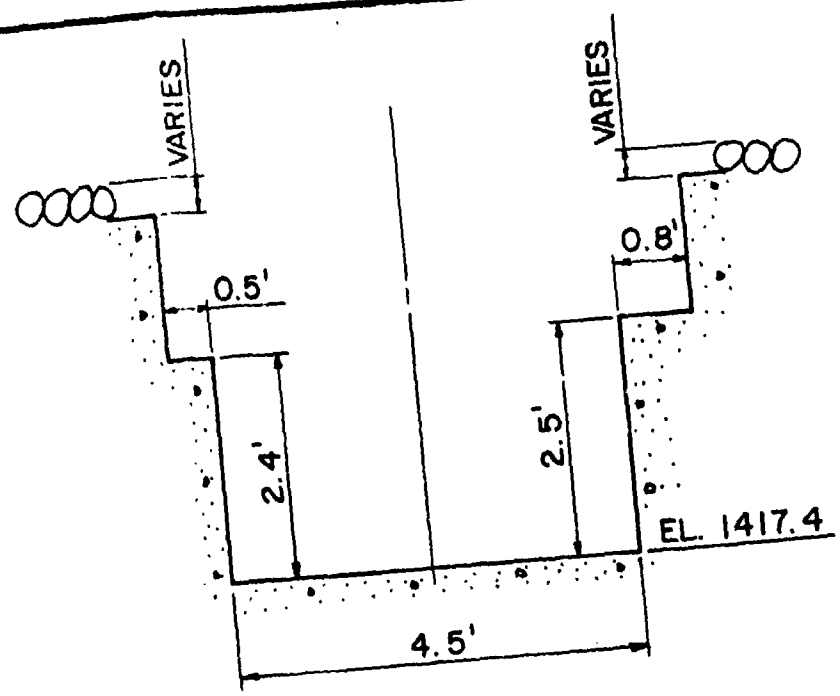
PLAN

JULY 1981 PLATE E-2

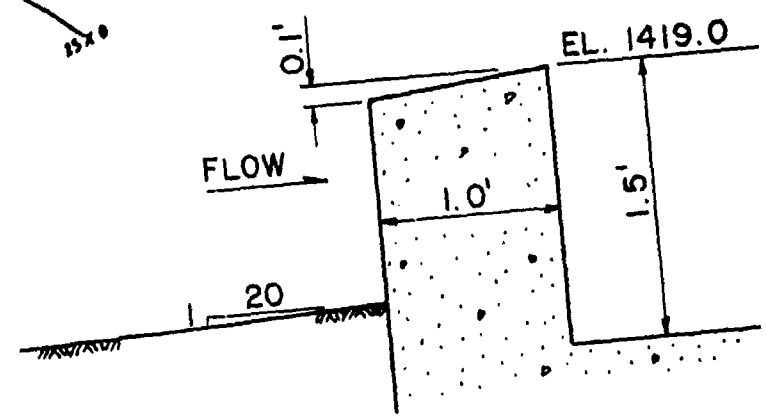


PLAN

SCALE: 1 IN. = 5 FT.



SECTION B-B
SCALE: 1 IN. = 2 FT.



SECTION A-A
SCALE: 1 IN. = 1 FT.

NOTE:
FOR LEGEND AND NOTES
SEE PLATE E-2.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
ELK LAKE DAM
ELK LAKE DEVELOPMENT ASSOCIATION, INC.
SPILLWAY DETAILS
JULY 1981
PLATE E-3

APPENDIX F

GEOLOGY

ELK LAKE DAM

APPENDIX F

GEOLOGY

Elk Lake Dam is located in Wayne County within the Appalachian Plateau Physiographic Province. The most pronounced topographic feature in the area is Camelback Mountain, which is part of the Pocono Plateau Escarpment. The escarpment has a well defined, southwestward trend from Camelback Mountain, but it is irregular between Camelback Mountain and Mt. Pocono, which lies to the north. Streams east of the escarpment drain directly to the Delaware River, while those to the west drain to the Lehigh River.

The Pocono Plateau Section lies to the west of the escarpment. This area is relatively flat, with local relief seldom exceeding 100 feet. The topography has been greatly influenced by continental glaciation. Many features were created by deposition of glacial materials. The entire plateau lacks well-developed drainage.

East of the escarpment is the Glaciated Low Plateaus Section of the province. This area is characterized by preglacial erosional topography with locally-thick glacial deposits. Local relief is generally 100 to 300 feet.

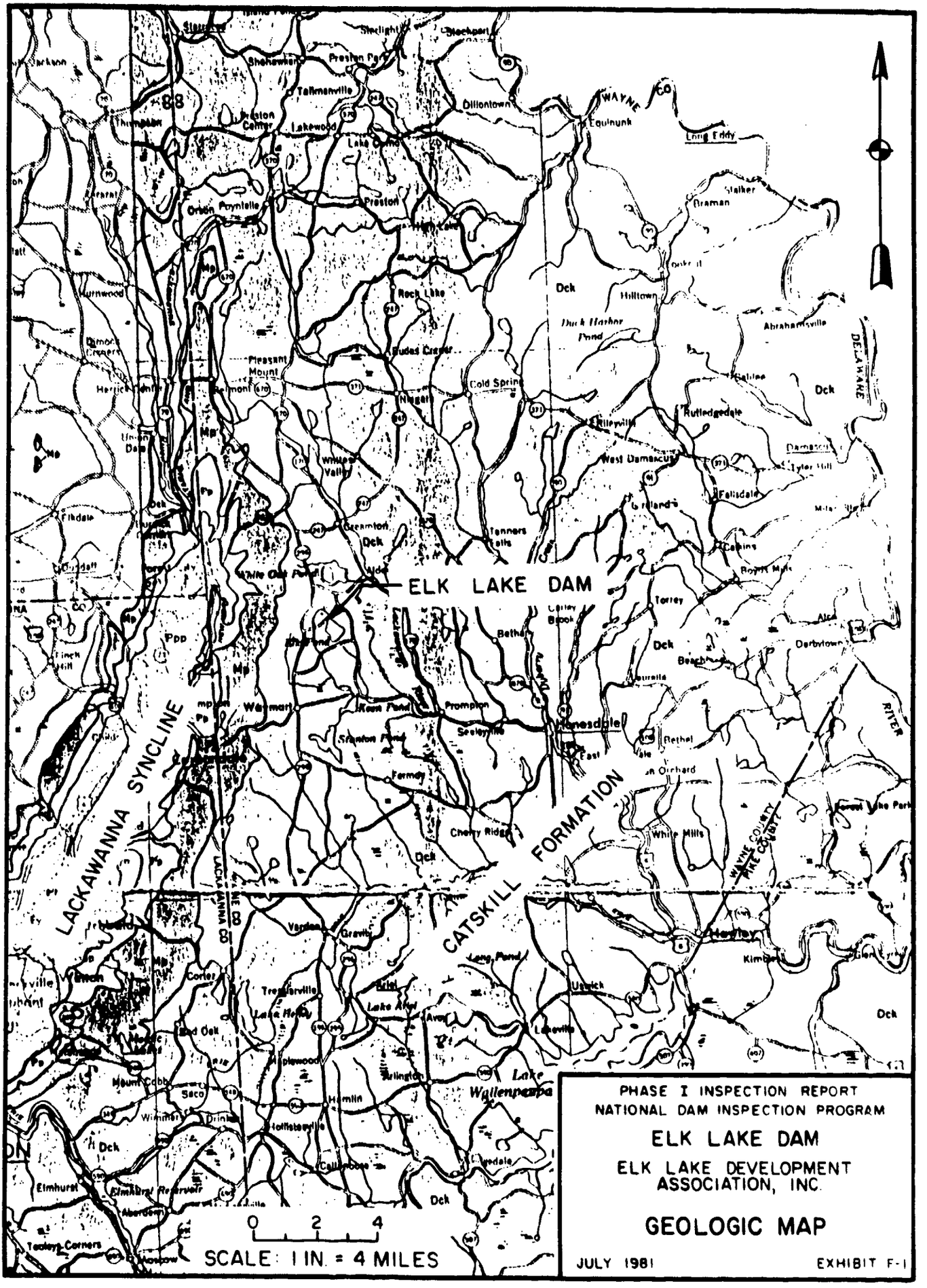
Bedrock units of the sections described above are the lithified sediments of offshore marine, marginal marine, deltaic environments, and fluvial environments associated with the Devonian Period. These units include siltstones of the Mahantango Formation, siltstones and shales of the Trimmers Rock Formation, and seven mapped members of the Catskill Formation. These members include sandstones, siltstones, and shales of the Towamensing Member; sandstone, siltstone and shale of the Walcksville Member; sandstones, siltstones and shale of the Beaverdam Run Member; sandstone and shale in the Long Run Member; sandstones and conglomerates in the Packerton Member; sandstones and some conglomerates in the Poplar Gap Member; and sandstones and conglomerates in the Duncannon Member.

Elk Lake Dam is underlain by the Catskill Formation. The Catskill Formation is predominantly red to brownish gray shales and sandstone with interbedded siltstones and conglomerates. Sandstones present are thickbedded, fine- to coarse-grained and exhibit very low primary porosity due to a clay and silica matrix. Effective porosity results from fractures and parting planes.

The rocks are well-indurated and generally are not susceptible to slope failure; however, the presence of well-developed bedding and joint planes will result in some rockfall from vertical and high-angle cut slopes.

Bedrock is entirely overlain by glacial till of Late Wisconsin Age. This till is an unsorted mixture of clay, silt, sand, and gravel. It is moderately cohesive and is generally derived locally from the sandstones of the Catskill Formation. Thickness of the till varies from 5 to 75 feet.

Foundation conditions at the damsite are not known. No rock outcrops were observed at the dam. The available records do not indicate the foundation conditions.



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

ELK LAKE DAM

ELK LAKE DEVELOPMENT
ASSOCIATION, INC.

GEOLOGIC MAP

JULY 1981

EXHIBIT F-1